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REPORT OF AN EXPERIMENT IN CORRELATED MATHEMATICS IN A LARGE HIGH SCHOOL.

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As the title indicates, this paper is a "Report" on an experiment. It is intended not to advocate any particular theory but simply to relate the trial of a theory and the judgment passed on its workability in a *large public* high school.

It is perhaps, in this last phrase: *large public high school* that the greatest significance of this experiment lies. For owing to their experimental nature and especially their independence of action, private and special schools are particularly fitted to advance theories and furnish leadership in educational matters. When the time comes, however, for advance ideas to be given a real "tryout," the public school which is not in a position to limit its conditions furnishes the fiery test.

Our high school which is of the traditional four year type, like so many others in this city and throughout the country has been greatly overcrowded owing to the great increase in enrollment. This has necessitated the shift system which results in great difficulty incident to finding times and rooms for helping backward pupils, holding of teachers' meetings without disturbing school work, and in the upper years, of holding together our groups classified for instructional purposes. Attendant with the great increase in enrollment has been the entrance of a larger proportion of pupils of lower intelligence rating. The private or special practice school since it draws from a more favored group of pupils and is in a position to control its attendance, does not give the new theory or course such a rigid test.

Three years ago with the consent of the Superintendent, our mathematics department by unanimous vote entered upon a three years trial of correlated or fused mathematics. It was

[1]Read before the Central Association of Science and Mathematics Teachers, Sem. H. S. November 28, 1924.

proposed to conduct the experiment in the ninth, tenth and eleventh years of the high school course.

The correlated course was first given to the freshmen entering Sept., 1921, and has been the regular first year work since then. It was first used by the 2-B classes in Sept., 1922, and was given to the third year classes in Sept., 1923. In addition to this the fused course was given during the summer school sessions of 1921, 22 and 23. All classes in mathematics were grouped by use of intelligence tests and this classification was maintained as rigidly as electives, demotions and exigencies of the program permitted. The department has thirteen full time, regular mathematics teachers who elect their chairman. Under the guidance of the chairman a set of minimum essentials was worked out in order to give special consideration to the lower groups, clarify aims and unify the work of the department. Each teacher was given an opportunity to take classes in both first and second year work so that he would be the better fitted to pass judgment on the course as a whole at the close of the experiment.

To provide machinery for measuring objectively the results of the experiment proved to be a problem. The most favored method would have been perhaps, to select two groups equal in ability as revealed by intelligence tests, place them under the same teacher: one class using the correlated course, the other the traditional course, and having controlled all other factors, to test them at the end of the year on objectives agreed to as standard. This type of experiment, prolonged and carried out extensively during the three years, would have yielded data on which scientific conclusions could be based. But the practical considerations of program making, especially the difficulty of keeping groups of students under controlled conditions for a very long period and the danger of working hardships on students through radical changes in their course in mathematics from semester to semester, made the plan inexpedient The plan finally adopted was to employ the "expert" opinion of the combined group of mathematics teachers and the principal, all of whom had former experience with traditional mathematics as well as with the correlated of the present experiment. To make this opinion more intelligent and weighted, a questionnaire based on the aims of mathematics instruction as set forth in the Report of the National Committee was found very helpful. To facilitate discussion a series of meetings was arranged by the

principal at which all phases of the experiment were discussed, and conclusions were formulated upon which all could agree. The conclusions reached were:

1. Correlated courses should avoid "*mixing*" of material rather than correlating it. A chapter of algebra should not be followed by a chapter of geometry with materials and solutions not unlike those of traditional mathematics. Algebra should be taught more from the geometrical view-point and geometry from the algebraic viewpoint in truly fused mathematics.

2. There should be a continuity of the fundamental topics, each subject being reasonably mastered before left. This makes for efficiency and saving of time, for the student on recurring to a topic will largely have lost what had been only partially done before.

3. If correlated mathematics is to bring in fresh material, enough of the old material must be discarded to prevent "*crowding*" of courses and text books. The attempt to master too much material and too many methods leads to loose thinking. Fewer topics should be taken up and better mastery obtained.

4. Truly correlated mathematics enriches the course and develops the relationship between algebra, arithmetic, trigonometry, and practical geometry. It allows, moreover, more scope for the psychological arrangement of material than the traditional mathematics.

5. If students master the fundamentals, they have more methods of approach to and attack upon mathematical problems than students of traditional mathematics.

6. Correlated mathematics permits the introduction of more graph and statistical material to illustrate the practical, social and scientific phases of everyday life.

7. The ninth grade work is especially suited for correlated work. The course in this year should treat mainly algebra, fused with trigonometry, arithmetic and a limited amount of intuitive geometry. It would appear that correlation would be very successful for all mathematics of the Junior High School.

8. The greatest difficulty, it was agreed, is caused by *Demonstrative Geometry*, and the problem of correlation is much more complicated for the *tenth year* than for the others. The members of the department were divided on this point, some maintaining that since Demonstrative Geometry contains so much of pure logic, it will not correlate with other branches of mathematics, while others argued that the relationship between logical geo-

etry and algebra, trigonometry and arithmetic could be developed in a correlated course All were agreed that once Demonstrative Geometry is started, if should not be interrupted by whole chapters of algebra or trigonometry.

9. In the third year, it was concluded that in view of the present organization of the course of study which permits a student to elect either one or two semesters of advance mathematics, these should consist mainly of either higher algebra or solid geometry, with as much correlation in treatment as is found possible.

In conclusion it may be stated that the experiment proved very stimulating to the teachers and has led to a great deal of discussion and investigation. The department voted unanimously to ask permission to carry on further experiment for additional three years.

AIR IS BLUE, PHYSICIST DISCOVERS.

Air is a blue-colored gas, according to recent investigations of Dr. C. B. Raman, noted Hindu physicist of the University of Calcutta. Dr. Raman is taking advantage of the brilliant sunlight of Pasadena for a year of research at the California Institute of Technology.

Classic school-books have always said that air is a colorless gas. To this Dr. Raman counters—"Look up at the sky." The advice is simple, although the obvious deduction from it has not been accepted in the past. In fact the blue color of the heavens has been attributed in recent publications to intensely cold nitrogen crystals in high altitudes. This ingenious theory is discredited by Dr. Raman as fanciful and at best entirely unproven and unnecessary.

Air-layers of ordinary thickness, such as one views within short distances do not reflect enough of the blue light to give a blue reaction on the retina of the eye. Dust amd moisture confuse the results in most cases, anyway. For exact observation, two plans logically follow. One is to examine a layer of clean dry air many miles thick, i. e., to behold the sky. When the test is made at high altitudes, the atmosphere overhead becomes too thin to exhibit the full blue color of the air, and the sky becomes blue-black, a color which merely indicates lack of reflection. Such an observation does not substantiate the frozen nitrogen crystal theory.

The second plan of observation, which is the basis of Dr. Raman's experiments at Calcutta, is to admit a highly concentrated beam of tropical sunlight into purified air in an intensely dark room. The experimenter has dubbed his dark chamber the "black hole of Calcutta." It requires a half-hour for the human eye to become thoroughly accustomed to the Stygian darkness of the "hole" before the blue color of the air can be observed.

The experiments of the Hindu physicist are conducted for the purpose of determining the form and structure of gaseous molecules. Success in the investigation will mean that a chemist may check his ideas of structure of drugs, dyes, etc., by the type of light waves which are reflected from the molecules.—*Science Service.*

BIRD STUDY IN HIGH SCHOOL BIOLOGY.

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There is no subject which is more worth while in high school biology from the esthetic side or from the point of view of science and pure natural history than the study of birds. The living bird may be studied in its own habitat, free and happy and engaged in its natural activities. The field study of birds arouses interests which are abiding. Aside from the fact that bird study provides for a worthy use of leisure time in the open air, it also shows the relation of birds to man's welfare and stresses importance of protection and encouragement. It is important for everyone to know that with a sufficient bird population, the greater part of the loss of $1,049,500,000 each year due to insects could be saved to the people of the country.

Field work on birds should extend throughout the year along with observations on insects, trees, fungi, weeds, and flowers. The study may assume the form of a survey of a suitable selected plot. In the country districts an ideal site could include the orchard and home lot. Location in the city is no excuse for omitting this essential part of the biology course. The nature of the work must be varied to meet the conditions. I have conducted field work from five different schools in Chicago, three of which were in the congested districts and I have found plenty of suitable spots easily accessible. The limited scope of this paper will not permit a detailed outline of the different types of field work which may be carried on in any given plot. One main line of investigation might be to determine whether there are enough birds in the area to hold the insects in check. This study would lead to the problem of determining what special features attract the birds to nest on the plot. The question, "Why is the bird here," calls for much clear observation. It is equally important to study the elements which account for a scarcity of bird life. The pupil must determine what necessities are absent. From these considerations it is only a step to the problem of determining what may be done to attract the birds to any given location.

Other lines of bird work that may be taken up relate to the destruction of weed seeds and to the control of rodents. The problem will involve a study of bird migration and means of providing for the winter birds so that they may be attracted within easy range of observation.

The spring migration calls for a study over a wider field with the emphasis on identification and related details. The opportunities offered for bird study in Chicago and in its immediate environs is a source of wonder. We have the parks, open spaces along boulevards, several wooded tracts and forest preserves along the river, all within the city limits. On the north side, we have been allowed access to Rose Hill Cemetery, a veritable bird paradise during the spring migration. Here may be found pied billed grebe, great blue heron, little blue heron, various species of ducks, loon, coot, thrushes, whippoorwill, barnswallow, chimney swift and a great list of others. Wild mallard ducks rear their young on the banks of the lagoons. In the back yards in the residence districts where there is a considerable growth of shrubbery may be found, especially during the migrating season, many different species. In our own back yard we have had such visitors as chewink, different thrushes, white-throated sparrow, brown thrasher, several species of warblers, scarlet tanager, catbird, cedar waxwing, Bohemian waxwing and many others.

With all of these opportunities for study, I felt justified, while teaching that work in the Senn High School in requiring every member of the classes to know at least twenty-five birds. Most of the pupils learned to know many more than that number. As I remember, the greatest number to the credit of any one pupil was 150 different species. The greatest number of differented species for all members of the classes for any one season was 250. Of course there were mistakes and some dishonesty but experience in checking up reports enables a teacher to reduce dishonesty to a minimum which is almost negligible. Various contests adds to the interest in this work. Trips are taken after school hours and before school hours, by the different classes accompanied by the teacher, but after the work is well started, the best work is done by the pupils themselves, either individually alone, or in small groups. I remember one pupil who was severely reprimanded when he returned home from a bird trip on a Saturday evening as late as nine o'clock. By Sunday morning he had the enthusiasm of the whole family aroused to the extent that they consented to go with him for an all-day trip.

For this work, the pupil should have a pair of field glasses, cheap ones will answer, a note book and a bird guide such as Reed's or Chapman's. Several laboratory copies of Chapman's Birds of the Eastern United States should be available.

I have seen no better treatment of general methods of bird study than that found in Hodge and Dawson's Civic Biology. Hodge's Nature Study and Life is also suggestive. Hornady's Our Vanishing Wild Life is good to help give a background for this and similar studies on conservation of our wild life.

In order to make any kind of a study of the economic relations of birds to man, we must know birds. Being able to identify the birds, to name them, is not enough. The pupil should have some knowledge of scientific classification. The laboratory should have mounted bird skins representing all of the orders of local importance and all of the common families of the perching birds. The different external characters which are used in identification are characters which are adaptations to the environment, so that important biological principles are stressed in such a way as to make permanent impressions. An excellent aid in the class work in connection with bird study is the stereopticon lantern. Slides made from photographs of the living birds are available which offer studies in color, habits and habitats of birds which aid in preparing for the field work. Other slides which show diagrams giving a graphic representation of the economic importance of different species help in fixing the importance of this relation.

Most of the success or failure of bird study in high school classes depends upon the teacher. He must develop an enthusiasm for the work that is contagious. He must realize the social importance of the information and training that bird study gives and attack the problems as a civic duty. The conservation of our wild bird life is a national, state and community problem and must depend upon each citizen knowing the different species and actually doing his part.

LINCOLN SCHOOL LABORATORIES.

It is a pleasure to read the description of these laboratories and will also cause a science teacher to congratulate the people who are responsible for such laboratories. It makes one feel that the cause of science and the way it should be taught is not on the down hill side, but on the contrary is making progress.

Dr. Caldwell, the director of the school, is responsible for the splendid equipment possessed by this institution. The wonderful arrangement of apparatus, tables, etc. shows that the school is fully aroused to the point where it believes in doing things well, and having arrangements of such a nature and character that this can be and will be done well.

Parties in the throws of arranging for new High Schools and Science Departments should visit this splendidly equipped school.

A YEAR IN BIOLOGY I.

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After having taught any subject through for one year, it is profitable, I think, to look back over the work. At such a time we should be able to identify the weaknesses of the course that has just been given. On the other hand, we may find some elements of strength. In what is to follow I shall try to summarize in broad outlines the year's work in high school biology that has just passed into history at the Oread Training School. This course was given during the school year 1923-24. In the first place, we must decide upon what our aims for the course are to be.

Now aims have always given me quite a bit of concern. Teachers of education have always emphazized the importance of aims. While still in college, I memorized Bagley's list. The list, I think, ran about as follows: *habits, ideas, prejudices, ideals, tastes, and attitudes.* You see that I have remembered them all these years. I have remembered them because I memorized the word which is made by putting together the first letter in each aim; "hipita." At that time, and for some years after, I was perfectly innocent of what habits, ideas, prejudices, ideals tastes, and attitudes might be the desirable ones. As time has gone on I have made the acquaintance of many other lists of aims of general education, and of biology in particular. The aims of general secondary education as set forth by the Commission on the Reorganization of Secondary Education, in Bulletin, 1918, No. 35, "Cardinal Principles of Secondary Education," have been a very great contribution. Mr. Bobbitt has stated the ultimate objectives of education in the form of activities. His next step is to list all of the abilities that are necessary in order that an individual may perform the necessary activities efficiently. The next step is to determine the states of mind (habits, ideals, prejudices, etc.), the knowledge, etc., that are necessary in order to have each ability. This, too, has been a great contribution. These contributions are especially valuable to all of us because they change our attitude toward education and lead us to make the student central rather than subject matter. The statement of more immediate outcomes of a course, however, is a different matter.

These may be our ultimate objectives, but what are we going to take as our goals from day to day in order that these objectives may be ultimately obtained? Mr. Bobbitt would say:

decide upon the abilities that are necessary in order to perform the activities of a biological nature and take these as our objectives. But when I am about ready to accept this suggestion, I begin to encounter difficulties. If I make a list of all the abilities that are necessary in order to perform the activities of life of a biological nature, I have a very long list of things. Now, if I take up each ability and teach it, I have gone back to the old encyclopedic method of organization. Furthermore, the list is so large that it would seem impossible to cover the ground. Another disturbing factor is the probability that, under our present rapid advance along all scientific lines, many of the abilities that seem necessary now may not be necessary in a few years hence. So, after chasing myself around in a circle time after time, and experiencing numerous headaches in the whirl, I am back where I started. I started with the idea that an understanding of and appreciation of the big and underlying principles and generalizations of biological science are our real objectives. In addition to this one dominant objective we may list a few others. The list is as follows:

(1) In the first place, we aim at attaining a changed attitude toward life through the understanding and appreciation of the big fundamental principles of biological science. With such an understanding must come a complete alteration of our methods of thinking and of our outlook upon life. After such an experience we look out upon a different world.

(In order that we may attain this one big objective, there are certain other things that we must keep in mind. It is by aiming at these that our ultimate teaching objective will be most easily attained.)

(2) In the second place, we must "develop the power to study" biological science.

(3) In the third place, we must put the student in contact, during the course, with a very great variety of biological materials in the hope that he will develop a "wide range of sustaining individual intellectual interests."

(4) In the fourth place, we aim at developing, as a final product, an individual who is "intellectually independent."

(5) In the fifth place, we shall aim to develop clear and forceful written and oral expression.

In any one course, we cannot expect to attain all of these objectives but by aiming directly at the last four we shall be able to attain them in a measure and we shall be able to attain objective No. 1.

I am indebted to many of my former instructors for the ideas expressed above. I am especially indebted for the ideas just expressed and for the teaching technique which I shall outline later to Mr. Henry C. Morrison of the University of Chicago.

Every teacher will have to determine what his teaching objectives will be. The important thing, however, is to distinguish teaching objectives from curriculum objectives, such as Bobbitts, and to realize the necessity of setting up teaching objectives. Most of us have no teaching objectives other than a certain number of pages to be covered within a certain time.

Now, when we set up some such teaching objectives as I have listed above, we discover to our amazement that such objectives cannot be obtained by the use of many of our present accepted methods of instruction. Some of our present practices that are brought into question are:

(1) The wandering through a text-book within a certain fixed time.

(2) The assignment of a daily lesson to be studied outside of class so that it can be reproduced in class.

(3) The limiting of subject matter to one single text-book.

(4) The assignment of marks according to the normal probability curve on the basis of whether a student has gotten his lessons, so that he can reproduce them in classs, seventy, seventy-five, eighty, eighty-five, or ninety per cent well.

(5) The idea that we must find out just what the best method (lecture, question and answer, developmental, project, socialized recitation, etc.,) is and use that particular method ever after.

(6) The segregation of laboratory work to certain fixed days of the week and the doing of laboratory work for the laboratory work's sake.

After deciding upon our teaching objectives, our next job was to plan our course for the year. This was done before school began. The important thing here is to select large blocks of material, generally called units, which are made up of principles, facts, and ideas, so closely related to each other that when a person thinks of the unit he at once thinks of the related principles, facts, and ideas which are involved in the unit. This is an important task and there is need for much scientific work at this point. Some of the units which were selected for the course were found to be good; others were found to be bad. The mastery of a unit, if it is a real unit of learning, means that, as a result, the attitude of the student toward the world has been changed. The units selected were as follows:

1. The difference between living and non-living things.
2. Inter-dependence of plants and animals. (A good unit.)
3. The life of a plant. (A good unit.)
4. "How an animal lives." (A good unit.)
5. A picture of the plant kingdom. (A good unit.)
6. A picture of the animal kingdom. (A good unit.)
7. "Tropism and the beginnings of intelligence." (A bad one.)
8. Evolution. (Good.)
9. Heredity. (Good.)

After the selection of the units for the course, the next step is to decide upon a teaching technique by which a mastery of these units can be attained. In the light of the aims already set up it seemed necessary to follow the following lines:

(1) Adopt a technique whereby we could teach each unit as a whole rather than by a series of daily lessons assigned to be studied outside of class and recited from memory in class.

(2) Adopt a technique whereby the instructor could have control of the learning situation during most of the time that the unit was being mastered. This means committing ourselves to some form of directed study.

(3) Adopt a technique that would give abundant opportunity for individuals to work out, independently, supplementary projects of interest to them.

If we are confronted by any problem, it matters not what its nature may be, we, either consciously or unconsciously, pass through certain stages on the way to its solution. In the first place, we take a survey to find out what we already know about the problem. In the second place, we determine the vital factors of the problem about which the necessary knowledge will likely have to be accumulated. In the third place, we accumulate the necessary material. In the fourth place, we make a selection and organization of the material which has been collected. In the fifth place, we do the job. If some such procedure is the effective method of getting things done in the practical world, it seems logical to adopt some similar method in working through any unit of material in biological science. We adopted, therefore, as the main lines along which to work, the technique which is the product of Mr. Henry C. Morrison and which is in use in the Laboratory Schools at the University of Chicago.

The first step, then, is the "exploration." This will generally take about one class period. In this period questions and exer-

cises are to be given which will tend to arouse interest in the unit which is to be studied. These will be of such a nature that the unit which is being approached will be tied up in the mind of the pupils with many past experiences. The pupils will be made conscious of the fact that there exist many problems in connection with the unit to be studied about which they do not know. Another important outcome of such a step will be the revelation to the teacher of just what the pupils already know about the unit. It is entirely possible that some may already have the "adaptations" that the unit is calculated to produce. In such a case the unit will have to be changed or those particular individuals given other work.

The next step is the "presentation." Here the teacher presents, in one class period or less, a "bird's-eye view" of the unit. This step is further calculated to arouse interest. It will indicate to the student the high points of the unit so that he can study it later in an intelligent manner. This is in accord with most works on how to study which point out the desirability of getting the general view before starting to work out details.

The next step is "assimilation." During this phase the student must, by his own effort, assimilate the material of the unit. This is the time for directed study and may extend over a period of from one to two or three weeks.

After "assimilation" the next step is to make an "organization" of the unit. This will cause the student to select and place the material that he has assimilated and will enable him to see the relationship of each part to every other part and to the unit as a whole. This will likely take one or two periods.

And, last of all, we shall set aside one or two periods for oral discussion of the unit. In this phase the pupils will be given an opportunity to stand on their feet and discuss the unit or some phase of it.

Thus, before we began our course, we had in mind our general plan of procedure for working through each unit. We also had a long list of possible supplementary projects. This list was to be merely suggestive because it is very important that a supplementary project be something in which the student is interested. If we were to attain our second objective; namely, the ability to study biology effectively, it was necessary for us to have worked out in some detail just what the desirable study abilities were. In order to satisfy this need, we started with the following list.

This list is simply a collection taken from various books

dealing with the problem of study, and picked up in various courses in education which I have taken. The list is as follows:

1. Skill in reading.
   a. This means that a student should be able to read biological material fairly rapidly; to vary the rate of reading; and to comprehend what is read.
2. The habit of reading with a specific purpose.
3. The ability to organize ideas.
   a. In order to have this ability a student should be able to pick out facts bearing upon the problem in mind; to neglect unimportant details; to make summaries of various kinds; to make outlines; to see and show the relationship between each part and the main problem under consideration and in this manner to advance his knowledge by groups of facts rather than by isolated facts of seemingly equal value.
4. The habit of supplementing thought.
   a. This implies the habit of asking questions of our reading, etc.
5. The ability of judging the soundness and general worth of statements.
   a. Here the reliability of the author; the credibility of statements, etc., must be considered.
6. The ability to use the most effective methods in answering the different types of thought questions.
   a. In developing this ability, the different types of problems must be fixed in mind and the best method of solution of each type must be mastered.
7. The habit of keeping a tentative attitude toward knowledge.
   a. In order to have this ability the student must be open minded; must not be hasty in generalizing; and must not make unsupported assertions.
8. Knowing when and how to memorize.
9. Ability to take notes.
   a. This is important both for lecture notes and for reading notes.
10. The ability to decide what type of study a given assignment calls for.
    a. Most assignments call for either memory work; drill work; or problem solving. Most assignments in biology will call for problem solving.
11. The ability to use a library effectively.
12. The ability to apply one's self for a long period of time to intellectual labor.
13. The ability to use ideas.

Such, in general, was the preparation for the work. When our teaching objectives had been decided upon; when our topical analysis had been made; when our teaching technique had been selected; and when the necessary study skills and abilities had been determined we felt that most of the preliminary planning for the course had been done and that we were ready for the first day of school.

"Guidance conferences" for freshmen students at West Virginia University are proving to be of value and interest. Addresses adapted to the needs and problems of university men are given and the students invited to take an active part in discussions. "The choice of a life career," "Intelligence tests," and "How to study" are among the subjects presented by students for discussion.—*School Life.*

THE BALLISTIC PENDULUM: A SIMPLE APPARATUS FOR STUDYING MOMENTUM AND ENERGY RELATION.

By Paul E. Klopsteg

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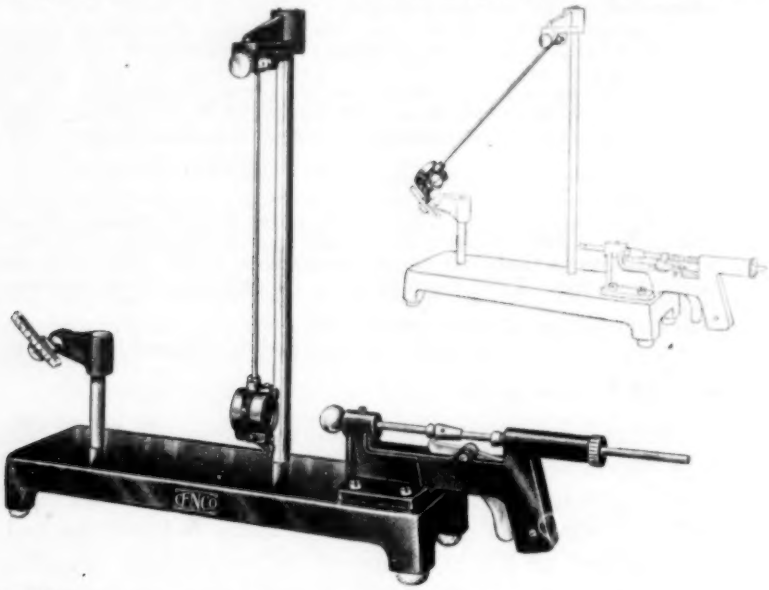
Textbooks of physics discuss the ballistic pendulum as an apparatus which makes possible the measurement of velocity of a projectile. The discussions are given to illustrate conservation of momentum. Laboratory manuals, on the other hand, offer few experiments to illustrate this principle, as was pointed out in an article by Professor O. Blackwood in this journal, volume 24, page 159, 1924. Although from practical considerations the ballistic pendulum has long since been abandoned as a device for velocity measurements, it probably remains the most useful means for studying the important relations expressed in or deduced from Newton's second law of motion. Possibly the laboratory manuals have avoided the ballistic pendulum because of the



[1]In the ideal ballistic pendulum illustrated in Fig. 1 the motion of the bob with reference to its center of gravity may be regarded as purely translational notwithstanding the fact that each particle of mass in the bob is moving along an arc whose radius is equal to the length of the suspension. In this case the total kinetic energy may be considered either as $\frac{1}{2}\ mv^2$ where v is the velocity of the center of mass, or as $\frac{1}{2}\ I\ \omega^2$, where I is the moment of inertia of the bob, found by considering the entire mass as concentrated at the center of mass and rotating on an axis equal to the length of the suspensions; ω is the angular velocity of the center of mass, which is the same as that of any other point in the bob.

hazard involved in the use of firearms in the laboratory. To overcome this objection Professor Blackwood devised a simplified pendulum in combination with a spring gun. A complete description of this apparatus was given in the reference cited.

Blackwood's ballistic pendulum differs from the ideal form in having its bob rigidly supported by a light rod with a single axis of rotation near the upper end of the rod. The consequence of this construction is that the motion of the pendulum is not purely translational[1] as it is in the ideal ballistic pendulum and which it is assumed to be in the derivation of the equations from which the velocity of a projectile is computed. In a physical pendulum like the one under discussion the motion may be considered as a translation of the center of mass combined with a rotation of the pendulum about an axis through the center of mass. The energy of motion of the pendulum is therefore divided between the two forms, translational and rotational. In Blackwood's apparatus the rotational part of the kinetic energy is so small that for practical purposes in the elementary laboratory it may be disregarded. Its presence, however, renders the pendulum a valuable apparatus for the more advanced laboratory also, because its discussion is an excellent lesson on the manner of division of kinetic energy when the motion of the mass is not purely translational. It is the purpose of this article to discuss this lesson.

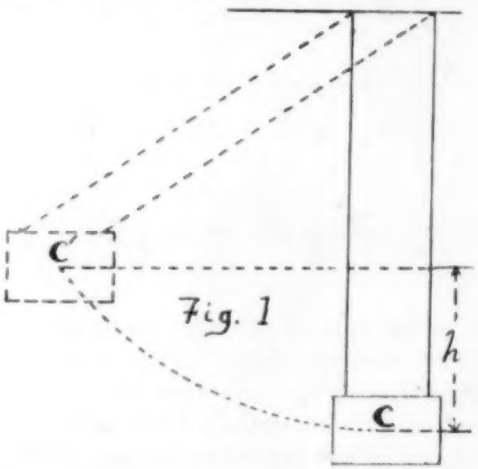


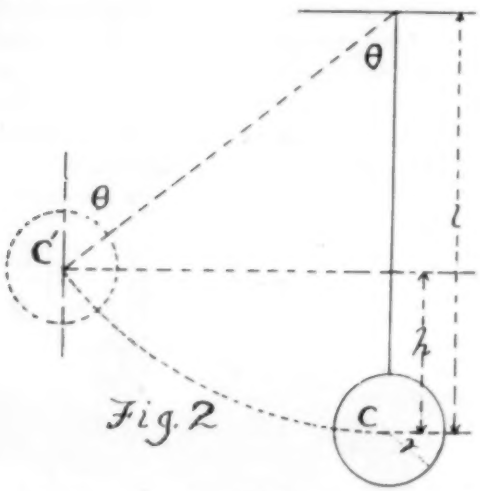
Figure 1 shows in diagram the usual form of ballistic pendulum having two parallel suspensions of negligible mass. The pendulum bob may swing along the arc CC^1 in the plane of the suspensions. The projectile is fired into one end of the bob and

embeds itself in the latter. In the motion of this pendulum every point in the bob describes an arc parallel to that described by the center of gravity C. It follows that no rotation about any axis through this point takes place. The usual procedure is to find the velocity of the projectile from an application of the principle of conservation of momentum in the system consisting of the projectile and the pendulum bob, together with the assumption that the total kinetic energy of the pendulum bob immediately after impact is equal to the increase in potential energy as the bob rises through the vertical height h. Letting M represent the combined mass of pendulum bob and projectile, and V its initial velocity along the arc CC^1, we may write the following equations:

$$1/2\, MV^2 = Mgh \qquad \text{(Eq. 1)}$$

$$V = \sqrt{2gh} \qquad \text{(Eq. 2)}$$

The equations closely represent the conditions realized in the experiment.



If in place of the type of pendulum represented in Fig. 1, a simple pendulum like that shown in Fig. 2 is used, the energy relations become less simple. Suppose that in this case the projectile strikes the pendulum bob on a horizontal diameter in the plane of the paper. The pendulum swings through an angle θ, its center of gravity rising through the corresponding height h. In this case the diagram shows that the spherical mass rotates through an angle θ about a diameter through C, perpendicular to the paper. Since there has been rotation of the kind described,

it is clear that some of the kinetic energy must have been rotational. As in Eq. 1, we equate the total kinetic energy immediately after impact with the increase in potential energy as the pendulum bob rises. From the fact stated, that the total kinetic energy of a moving mass is the sum of the kinetic energy due to the linear velocity along CC^1 of the center of mass, and the kinetic energy due to the angular velocity of the mass about its axis through the center of mass, we may immediately write the complete equation

$$1/2\,MV^2+1/2\,I_c\omega^2 = Mgh \qquad \text{(Eq. 3)}$$

In this equation M, V and h have the same meanings as in the preceding equations; I_c is the moment of inertia of the mass about a diameter through C and w is the angular velocity of the mass immediately after impact. For the simple pendulum with a spherical bob of mass m, I_c has the value $2/5\ (mr^2)$, and in this particular case ω corresponding to the initial velocity of the pendulum has the value V/l. These values when substituted in Eq. 1 result in the relation

$$V = \sqrt{2gh\left(\frac{1}{1+\frac{2}{5}\frac{r^2}{l^2}}\right)} \qquad \text{(Eq. 4)}$$

A comparison of Eqs. 2 and 4 shows them to be of the same form but that in Eq. 4 there is a "correction factor" to the

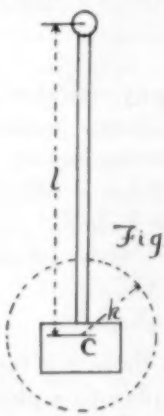


Fig. 3

quantity $2gh$ which comes from the rotational part of the energy. The equation shows that if the kinetic energy of rotation is disregarded, which is equivalent to assuming its value as zero, the value of V as found from the equation will be too large. The error resulting in this case becomes smaller with decreasing r and

increasing l. This follows also from the fact that if r is decreased the moment of inertia of the sphere becomes smaller, and as l is increased the ratio between linear and angular velocities becomes greater.

An example will give a more concrete idea of the magnitudes involved. Let l be taken as 40 cm and r as 2 cm. The factor within the parentheses in Eq. 4 then becomes 0.999 and the error in V which results from disregarding this correction is only 0.05%.

The discussion just given for the ideal simple pendulum illustrates the process of reasoning which is applied to the physical pendulum when used as a ballistic pendulum, as in Blackwood's apparatus. Fig. 3 shows a diagrammatic sketch of the pendulum. Consider that the ball has been fired into the bob, and that the center of mass C is common to the pendulum and ball. The distance between the center of mass C and the axis of suspension S is known, but the moment of inertia of the pendulum about an axis C perpendicular to the paper is unknown. This latter quantity must be found if we are to compute the magnitude of the rotational kinetic energy.

Let the radius of gyration of the pendulum about the axis through C be k, and the corresponding moment of inertia I. If M and m represent the masses of the pendulum and the ball respectively, we have from the definition of moment of inertia the relation

$$I_0 = (M+m)k^2 \qquad \text{(Eq. 5)}$$

We may now write the energy equation, corresponding to Eq. 1 for the simple pendulum, taking ω as the angular velocity of the pendulum immediatey following impact. The equation is

$$1/2(M+m)V^2+1/2\,I_0\omega^2 = (M+m)gh \qquad \text{(Eq. 6)}$$

The value of ω, as before, is V/l. By making the proper substitutions for I_0 and ω in Eq. 4 we find V to be

$$V = \sqrt{2gh\left(\frac{1}{1+k^2/l^2}\right)} \qquad \text{(Eq. 7)}$$

This equation again is in the same form as equation 4 with a correction factor which applies to a physical pendulum because of its rotational energy. From the equation we see that the error which results from the assumption that the rotational kinetic energy is negligible becomes small if k is made small and l large. It follows that if the length l has been fixed by practical considerations, then k, the radius of gyration about the center of gravity is made a minimum by using the lightest possible material for

the supporting rod, and by designing the pendulum so that its moment of inertia about its center of gravity is small.

It is finally of interest to get some idea of the magnitude of the error which results when V is computed from measurements made with Blackwood's pendulum, disregarding the rotational kinetic energy. Referring again to Eq. 7, we note that if we can find the value of k, we shall be able to compute the error mentioned, since all other data needed are easily obtainable. Finding k is not a difficult matter.

In a body of irregular shape, of mass M, suppose we know the moment of inertia I_c about an axis through its center of mass; then the moment of inertia I_s about another parallel axis, at a distance l from the first is $I_s = I_c + Ml^2 = M(k^2+l^2)$. If such a body is suspended so as to vibrate about the axis through S, its period will be given by $T = 2\pi\sqrt{\frac{I_s}{Mgl}}$, and if the value of I be substituted, we have $T = 2\pi\sqrt{\frac{k^2+l^2}{gl}}$.

Since g and l are known, and T can easily be found by setting the pendulum swinging and timing it with a stopwatch, we can find k by this equation.

In the experiment as described by Prof. Blackwood a comparison is made between the velocity as measured by the use of the pendulum and the velocity as found from a measurement of the vertical and horizontal components of the path of the projectile when fired horizontally and allowed to fall freely to the floor. The two velocity values so found may differ by several per cent because of experimental errors. For this reason it is entirely proper in high school and beginnng college courses to treat the physical pendulum in the Blackwood apparatus as an ideal ballistic pendulum, omitting all reference to the small amount of rotational energy. By actual measurements, k has been found to be about 7 cm., and the error introduced in the result by disregarding rotational energy does not exceed 3%.

A new college for women is to be established at Bennington, Vt. In its organization an attempt will be made to economize time and expenses of students. By eliminating long vacations both at Christmas and during the summer the founders hope to help students in three years to meet all the requirements of a regular college degree.

In providing homes for teachers, Texas claims first place; a recent report to the United States Bureau of Education shows a total of 635 for that State. Nearly 600 of these homes are in rural districts.

CORRELATION IN NON-LINEAR TYPES.

By WILLIAM R. RANSOM,
Tufts College, Mass.

If determinations are made of N values of a quantity, y_n, for various values of a second quality, x_n, *and there is reason to suppose that they are connected by a linear relationship*, $y_n = ax_n + b$, a preferred linear equation may be sought by determining a and b, so as to minimize the sum of the squares of the differences between y_n and $ax_n + b$.

If we choose as origin the center of gravity of the points (x_n, y_n), so that $\Sigma x_n = 0$, $\Sigma y_n = 0$, we have

$$S = \Sigma(ax_n + b - y_n)^2 = \Sigma(a^2x_n^2 + b^2 + y_n^2 + 2ax_n - 2ax_ny_n - 2by_n)$$
$$= a^2\ \Sigma x_n^2 - 2a\Sigma x_ny_n + Nb^2 + \Sigma y_n^2$$

$$= \Sigma x^2 \left[a - \frac{\Sigma x_n y_n}{\Sigma x_n^2} \right]^2 + Nb^2 + \Sigma y_n^2 \left[1 - \frac{(\Sigma x_n y_n)^2}{(\Sigma x_n^2)\ (\Sigma y_n)^2} \right]$$

The first two terms are never negative and S takes on its minimum value, S_m, when they are zero. So

$$a = (\Sigma x_n y_n) \div (\Sigma x_n^2), \quad b = 0,$$

gives

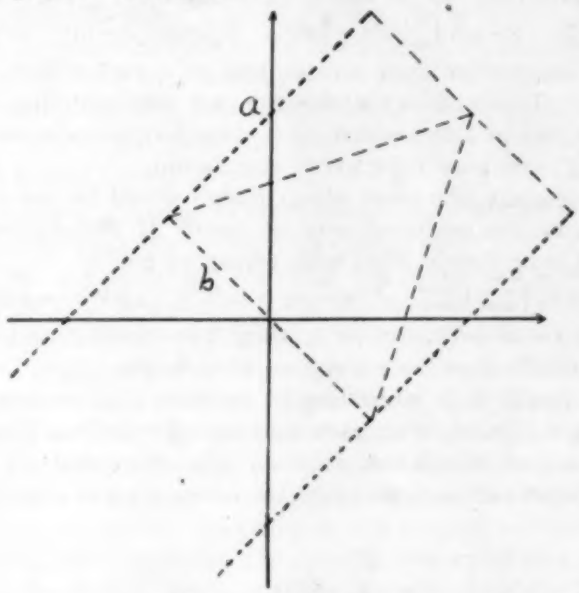
$$S_m = \Sigma y_n^2 \left\{ 1 - \frac{(\Sigma x_n y_n)^2}{(\Sigma x_n^2)(\Sigma y_n^2)} \right\}$$

The quantity subtracted from 1 in this formula is denoted r^2 and r is called the *correlation coefficient*. Its value is unaltered if the units are changed in which x and y are measured and so r seems to have a real meaning regarding the quantities themselves. Its value is unaltered also if the number of points is doubled, etc., without altering the mode of distribution, and so r seems to represent a property of the distribution. If $r^2 = 1$, the points must exactly satisfy the linear relation, $y = ax + b$, for then $S_m = 0$. On the other hand, if $r^2 = 0$, $\Sigma x_n y_n = 0$, and so $a = 0$, and as $b = 0$ in the minimum value of S, S_m reduces Σ to Σy^2. That is the sum of the squared discrepancies reaches the sum of the squared ordinates, which seems to be as bad as the discrepancies could be. It is therefore natural to *feel* that the scale of values from $r^2 = 0$ to $r^2 = 1$ represents an increasing scale of excellence of the straight line representation for the (x_n, y_n).

But some who calculate correlation coefficients seem to carry this feeling too far, and to overlook the qualification that there should be reason to suppose a *linear* relation, and even to treat

the scale of values for r^2 (or r) as a scale of probability that there is *some* relation. It is the object of this paper to point out that with nonlinear types of relationship: 1. The value of r^2 throws no light upon the question "Is there a relationship?" and 2. Various values of r^2, from 0 to 1, can be obtained from a single type of relationship.

1. There can have been no relation between these two things: the order in which Washington, Adams and Jefferson came to the Presidency and the number of slant strokes in their surname initials; but the correlation calculation gives what is commonly called "perfect correlation":



	order	strokes	x	y	xy	x^2	y^2
W:	1	4	2	−1	−2	4	1
A:	2	2	0	0	0	0	0
J:	3	0	−2	1	−2	4	1
sums	6	6			−4	8	2
cen. grav. 2		2					

$$\therefore r^2 = (-4)^2 / (8 \times 2) = 1.$$

On the other hand we are convinced that there is a strict relation between the height of the tide and the hour angle of the moon. In the ideal case this relation would be represented by points uniformly distributed along a sine curve. If one arch of the curve is taken, there is a negative xy for every positive xy, and so $r^2 = 0$.

2. Suppose the correlation method is applied to a problem in which data from two separate linear relations are mixed. Let the points determine two parallel lines. By choosing suitable units for y the lines may be given the 45° slope, and we will denote their common length by $2a$ and their distance apart by $2b$. The lines determine a rectangle and its center must be taken as origin. To facilitate the calculations rotate the x and y axes to a new pair, u and v, so that $x=(u+v)/\sqrt{2}$ and $y=(u-v)/\sqrt{2}$. Since the distribution is symmetrical $\Sigma x^2=\Sigma y^2$, and so $r=\Sigma xy/\Sigma x^2=(\Sigma u^2-\Sigma v^2)/(\Sigma u^2+\Sigma v^2)$, the term $\Sigma 2uv$ vanishing as a result of symmetry. $\Sigma u^2=4\int_0^a u^2du=4a^3/3$, $\Sigma v^2=4\int_0^a b^2du=4ab^2$. Whence $r=(a^2-3b^2)/(a^2+3b^2)$. This varies from zero to one as a varies from $b\sqrt{3}$ to infinity. It is well to examine the case corresponding to "zero correlation" in this problem as a corrective for any unfounded "feeling" one may have about correlation.

A case more like those often treated would be one in which the points are scattered over an area. If the rectangle just treated is uniformly filled with points we get

$$u^2=4\int_{u=0}^{u=a}\int_{v=b}^{v=a} u^2\ du\ dv=4a^3b/3, \text{ and } v^2=4ab^3/3$$

so that $r=(a^2-b^2)/(a^2+b^2)$, which runs from zero to one as the rectangle goes from a square to a stripe.

And finally it is interesting to consider that relation which, next to the linear, is simplest and most frequent. What is the coefficient of correlation between a number and its square? If we begin with zero and take the integers up to n we have the values

$n=$	1	2	3	4
$r^2=$	1	.9231	.9184	.9195

While if points are taken continuously along the range from zero to a with uniformly distributed abscissas we get $r^2=.9375$ whatever the value of a. On the other hand, if the ordinates are uniformly distributed we get $r^2=.9600$ whatever the value of a. Thus in the case of a quadratic relation the correlation coefficient has by no means the quality which makes it useful in testing linears.

There are many test questions presented. Mechanically the book is well made. It is in ten-point type, many of the questions and tables being set in eight-point. It is printed on uncalendered paper of good grade, and is a book that everyone interested should purchase and study.

RELATIVE VALUE OF DIFFERENT TYPES OF QUESTIONS IN READING TESTS.

By Sterling G. Brinkley,

Illinois College, Jacksonville.

THE PROBLEM: The subject of this study is narrower than is indicated by the title given it. "Reading tests" are limited to silent reading tests of the type of the Thorndike-McCall Reading Scale, designed to measure depth of power of comprehension in reading. Only three "types of questions" are considered: the true-false, the multiple choice or selective response, and the word or phrase answer type. The comparison of "value" is limited to one point, that of validity or the extent to which the test measures the ability it is supposed to measure. The question for study may then be better stated as follows: What is the relative validity in a silent reading test of the kind indicated of true-false questions, multiple choice questions, and word or phrase answer questions?

This study of the types of questions for reading tests is a phase of a larger problem undertaken two years ago. When Prof. W. A. McCall of Columbia University was serving as Director of Psychological Research for the Chinese National Association for the Advancement of Education, I undertook in coöperation with this organization the construction of an English reading test. As previous use of the Thorndike-McCall Reading Scale in Chinese schools had demonstrated its value for measuring reading and general English ability where English was a foreign language, my procedure was to adapt this test to the situation. In doing this all poetry was omitted, new reading selections were introduced, all duplication of selections in parallel forms of the test was eliminated, the vocabulary was zoned on the basis of Thorndike's *Teachers' Word Book*, and idioms likely to cause unusual difficulty to the foreign student were changed. In order that the test might involve only reading, it was decided to construct questions of the multiple choice type. Thus the written answer was avoided. Four forms of the reading test were constructed and standardized for Chinese schools.

The problem of the validity of the multiple choice type of test was raised by this larger study. Data bearing on its solution were gathered, but it is only recently that there has been opportunity to go back to the original data collected and complete the study.

THE TESTS USED IN THE STUDY. The following sample taken from Form 1 will illustrate the types of questions compared. The paragraph chosen is one of the easier paragraphs, containing only words from Thorndike's first 500 as to frequency of occurrence.

SAMPLE OF TESTS:

Once there was a rich man who got up early one morning and placed a great stone in the road. He wanted to see what people would do when they saw it. That day he saw men, women, and children pass by. Each one looked at the stone and then walked or drove around it. At last, just at dark, a boy came along. He said to himself: "Someone may fall over this stone. I will try to move it." He worked and worked until he moved it away. Then he saw a box which had been lying under the stone. When he opened the box, he found that it was filled with gold.

Type A Questions. Multiple Choice (From Form 2A):

1. The stone was placed in the road (a) by the rich man, (b) by a boy, (c) by a group of people, (d) by some children.
2. The box of money was found (a) under the stone, (b) in a house, (c) by the side of the road, (d) in a hole in the ground.
3. Why did the boy move the stone? (a) Because he thought some one might fall over it. (b) Because he wished to see if he could move it. (c) Because the people would all know about it. (d) Because he wished to find some money.
4. Most of the people who passed along this road (a) tried to move the stone, (b) moved the stone, (c) fell over the stone, (d) went around the stone.

Type B Questions. Word or Phrase Answer (From Form 2B)

1. Who placed the stone in the road?
2. Where was the box of money found?
3. Why did the boy move the stone?
4. What did the men do when they saw the stone in the road?

Type C Questions. True-False (From Form 2C)

1. Was the stone placed in the road by the boy?
2. Was a box of money found under the stone?
3. Did the boy move the stone away?
4. Did the people who passed along this road fall over the stone?

It is evident from the reading of the different types of questions that for any given paragraph the questions of one type cover the same facts as are covered by the questions of the other two types. This is true of the tests as a whole. The paragraphs of Form 1 were thus used in three tests, Type A having the multiple choice questions, Type B the word or phrase answer questions, and Type C the true-false questions. Similarly, there were the three types of questions grouped in three separate tests for Form 2 and for Form 3.

Forms 1A, 2A, 3A (that is, Forms 1, 2, and 3 of the reading test in each of which the Type A, or multiple choice questions, were used) were of equal difficulty, as determined by results got when they were administered to a group of 100 pupils. The arithmetical means were respectively 25.6, 24.9, and 24.1. It was assumed that this same approximation of equality between the forms existed in the case of the Type B and Type C questions

also. The three forms with the Type A questions had a length of 50 minutes each (the average time used by the pupils in taking the test). The length in minutes for the Type B and Type C tests was not determined. The number of items was of course the same as in the Type A tests.

THE CRITERION. The study undertook to determine the relative validity of the three types of questions. The validity of a test is determined by comparing it with a criterion. Two types of criteria were possible. (1) The first was a composite of the scores on the three reading tests being compared. The advantage of this criterion is that it is a criterion of *reading ability*; its disadvantage lies in the fact that spurious correlation is present due to the inclusion of the test studied in the criterion. (2) The second was a measure of general ability in English. The English department gave at the close of the semester six standard tests covering varying phases of English ability. These were: Thorndike-McCall Reading Scale, Kelley-Trabue Completion Test, a spelling test made up from Ayres Spelling Scale, and three tests of the English Mastery Series, published in Shanghai; i. e., Grammar-Idiom, Word Opposites, and Auditory Comprehension. A composite of the results on these six tests was made, by giving to spelling and auditory comprehension each a weight of one-half while each of the other tests received a weight of one. This composite gave, it was believed, a very accurate measure of general ability in English. It had been shown in a previous study, that there was a fairly high correlation between ability in reading as measured by the Thorndike-McCall Reading Scale and general English ability[1]. These facts were taken to justify the use of the general criterion. The fact that this criterion did not contain any of the tests being compared led to its acceptance in preference to the more specific reading criterion.

THE SUBJECTS. The subjects in the experiment were the pupils of the Soochow University Middle School[2]. Only those who took all the tests were included in the final computations. The number was 226. The school is a college preparatory school for boys. The course of study covers seven years. English is begun in the first year and is compulsory throughout the course. For the purpose of the experiment the pupils were divided into two major groups, Group I and Group II. Group I was com-

[1]The Use of American Tests to Measure English Teaching in China, Journal of Educational Research, Sept. 1923, Vol. 8, No. 2.
[2]Located at Soochow, China.

posed of the pupils who had taken the original forms of the reading test, Type A, in April, when it was administered for purposes of try-out and scaling. The remainder of the pupils of the school made up Group II.

The pupils of Group I were divided into two sub-groups, designated as V and W. The division was carried out by the method of pairing so as to render the groups of equal ability in English. The pupils of Group II were divided into three sub-groups in the same way. These groups were designated as X, Y, and Z. That the sub-groups within each major group were closely similar groups is seen by the fact that the averages and standard deviations of the scores made by these groups on the criterion composite are almost identical. (Table I.)

ADMINISTRATION OF THE TESTS. With one exception the tests were at the close of the semester in June, 1923. The exception was in the case of Group I, which had taken the Type A tests in April. In June this group was given Form 1B and Form 1C, and the scores made on Form 1A in April were compared with these. The two tests in June were given during one two-hour period. The order of giving the two tests was rotated in order to eliminate the probable practice effect due to the identity of content in the tests and any fatigue effect due to the taking of the two tests at one sitting.

To Group II were administered three tests on two consecutive days, two being given at a two hour period on the first day. Any specific practice effect was eliminated with this group by using all three forms of the test, making it possible to have different content on each occasion. Thus Sub-group X took as its three tests Form 1A, Form 2B, and Form 3C. In this way no group of pupils had the same paragraphs twice and no two groups of pupils had the same questions. Moreover, there was rotation of types so that there might be eliminated whatever advantage or disadvantage was present due to the time and order in which the tests were taken. (Thus Type A was administered first to Group Z, second to Group Y, and third to Group X. For the first test Group X had Form 2B, Group Y had Form 2C, and Group Z had Form 2A. These illustrations should make clear the type of rotation.)

To sum up: Group I had the same content in all three of the tests taken. For this group the variable factors were type of questions, and time and order of taking the tests. The rotation in administering the tests was such as to give the advantage of

practice now to one type and now to another. Group II had different content in each of the tests taken, but the difference was only that between parallel forms of the same test; the rotation in administration here served to balance advantages of position and order of tests in the series. Correlations were computed for each of the five groups separately.

As a result of this method of administering the tests, the three types of questions are compared under the following conditions: (1) When the content is the same, the pupils the same, and the time of taking the test varies, (Table II, Group I); (2) When the content is the same, but the pupils are equal groups rather than the same pupils, and the time of taking the tests is the same; (3) When the content is equivalent (parallel forms) rather than identical, the pupils the same, and the time of taking the test varies (Table II, Group II). It would seem that differences between the tests shown after all these comparisons are combined must be due to the type of question used.

RESULTS OF THE STUDY. The results of the comparisons are shown in Table II. The word or phrase answer test gives in every case the highest validity coefficient. The multiple choice test gives a higher coefficient in three out of the five comparisons and a lower validity coefficient in the other two. The average is in favor of the multiple choice test. The differences revealed are not great, whether considered separately or in the average. The data do not lend themselves to the mathematical determination of the significance of these differences. Since the word or phrase answer test is superior to the other two in every comparison, the average difference of .04 between it and the multiple choice test and of .07 between it and the true-false test is more likely to be a *real* difference than that of .03 between the multiple choice test and the true-false test.

The data may be interpreted, therefore, to indicate a slight but real advantage in validity of the word or phrase answer test over the other two and no essential difference in validity between the multiple choice and the true-false tests. These conclusions based on a study of reading tests are in agreement with the conclusions of a more thorough study of types of tests in the field of history made by the writer.[3]

[3]Brinkley, S. G., Values of New Type Examinations in the high school, with Special Reference to History, Teachers College, Columbia University, Contributions to Education, No. 161.

TABLE I. MEANS AND STANDARD DEVIATIONS OF TESTS.

	No. of Pupils	Criterion		Type B		Type A		Type C	
		Arith. Mean	S. D.	Arith. Mean	S. D.	Arith. Mean	S. D.	Ar. Mean	S. D.
Group I. Sub-group V	50	104.7	25.9	28.3	10.4	25.0	12.1	28.3	12.1
Sub-group W	49	104.5	26.5	32.1	11.9	25.9	12.1	28.1	12.3
Group II. Sub-group X	40	104.2	16.9	23.2	6.3	27.9	8.2	24.2	7.0
Y	44	104.6	17.0	29.4	6.3	23.6	7.1	24.9	8.9
Z	43	104.1	16.7	27.5	7.0	25.0	7.0	26.8	7.8
Unweighted Mean	45			28.1		25.5		26.5	

TABLE II. CORRELATIONS OF EACH TEST WITH THE CRITERION.

	Correlations			P. E. of Correlations			No. of Pupils
	Type B	Type A	Type C	Type B	Type A	Type C	
Group I.							
Sub-group V	.92	.91	.88	.015	.016	.022	50
Sub-group W	.94	.92	.86	.011	.015	.025	49
Group II.							
Sub-group X	.84	.80	.67	.032	.037	.059	40
Sub-group Y	.89	.83	.85	.021	.032	.028	44
Sub-group Z	.84	.78	.82	.030	.040	.034	43
Unweighted Mean	.89	.85	.82				

REAL-ESTATE PRACTICE TO BECOME AN EXACT SCIENCE.

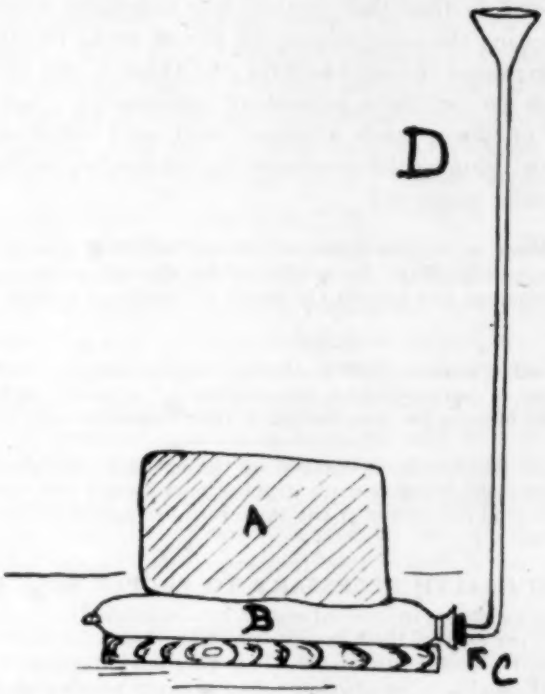
The real-estate dealer of the new day will be trained in his vocation, even as the engineer, the dentist, the lawyer, the physician is trained in his. In order to cover the wide range of information which the realtor needs, the committee on educational courses of the National Association of Real Estate Boards has outlined a curriculum covering 12 subjects. Already three books for this course have been published and three others are promised, says Ernest M. Fisher in *School Life*, a publication of the Department of the Interior, Bureau of Education. In addition an extension course by mail is planned by the American Real Estate Institute, a department of the national association.

About 30 universities and colleges have either adopted a part of the course or are seriously considering it, Mr. Fisher states, and the national association, realizing that the setting up of higher requirements and standards will dignify the profession and bring into it men of higher ability, recommends that universities and colleges permit under-graduate stuents who desire to choose real estate as a major study.

APPARATUS FOR DEMONSTRATING THE HYDRAULIC PRESS.

By Harold H. Metcalf,
High School, Monroe, Wisconsin.

Few of us can afford, to spend money for an expensive set of apparatus with which to demonstrate Pascal's Law and the hydraulic press. Yet the study is important to a thorough understanding of liquid pressure and it is interesting possibly because of the simplicity of the materials needed.



The diagram shows clearly the structure of the press. A good grade of rubber hot water bottle can be procured at a small cost. It should be at least ten inches long and eight inches wide. The neck should be round and should take perforated rubber stopper (c) into which can be tightly fitted a piece of one half inch hard glass tubing. Attaching a funnel to D by means of a rubber tube makes it easier to pour water into the press. A board of known area ought to be put between the water bottle and the mass (A) which may be a piece of iron weighing fifty pounds or less. Unless the stopper is securely fastened, the pressure of the water will release it.

In order to operate the press, water is carefully poured into the tube (D). The mass will rise slowly if care is taken to keep it properly balanced upon the bottle. It is interesting to have the pupils calculate the weight of the iron after the instructor has measured the area of the bottle in contact with the board and the difference in levels of the water. This value should compare favorably with the true weight of the iron as measured by a scales-balance.

There are many teachers of Physics who are apparently handicapped in that they cannot buy expensive apparatus for demonstrating the more important principles in Physics. They have little money to spend and they find that it can to a greater advantage be put into laboratory equipment. But one can in many instances teach a subject well, and yet develop more interest by using appliances made by the teacher or the student out of crude material.

Delinquency in studies decreased 60 per cent last year at Lawrence College, Appleton, Wis. It is believed by the college authorities that the improvement was largely the result of freshman courses in how to study.

Vocational schools in several Michigan cities have assisted the State organization of parent-teacher associations by printing without charge its monthly bulletin for distribution in their respective districts.

Travel by teachers is encouraged by the board of education of Tulsa, Okla. Every third summer any teacher who spends the vacation time in travel is paid full salary at the same rate per month as in the regular school term.

GOOD HEALTH NECESSARY TO PROPER EDUCATION.

How can we expect to force education into individuals who are spending at least 50 per cent of their energy, which is needed for their studies, in fighting their physical handicaps? This question is presented by George T. Stafford, M. D., in an article in the February number of *School Life*, a publication of the Department of the Interior, Bureau of Education.

Out of 1,940 University of Illinois men examined in 1923, 1,193 had either poor or fair body development, 95 had defective hearts, 109 had albuminaria, 65 had hernia, 62 admitted that they were constipated, 541 had round shoulders, 347 had hollow backs, 342 had lateral curvature of the spine, 350 had flat feet, Doctor Stafford says.

We need closer cooperation between the school and the home in matters of health, he continues. Parents must be made to see the value of health to their children. The economic gain and the necessity for healthy motherhood must be stressed. Preschool examinations are growing in favor; they are generally given in May or June, and the parents then have until September to provide the necessary medical attention. There must be better examples of health in the teaching profession. With the teachers won over to health, it means better work by them and real health teaching for the students.

THE CHARACTER OF LABORATORY WORK FOR STUDENTS OF ELEMENTRY CHEMESTRY.

By W. G. Bowers,

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In selecting the type of exercise to offer students in their first year's laboratory work, two conditions must be considered. First, what is the beginning student able to do, and second, what is the student going to make of himself in the future?

In the past, many teachers and writers have expressed themselves as though the second condition was the only one to be reckoned with. They seem to neglect the fact that many things are impossible to the beginner or that they impede his progress. They have learned from the new methods in pedagogy that it is easier to teach a child first to read and then to spell than to teach him first to spell and then to read. They conclude that the way to apply that to teaching of chemistry is to teach the beginner first the practical and then the theoretical. That seems on first thought to be alright and it seems in the first few weeks of effort in the teaching of elementary chemistry in the laboratory to be a sensible view of the pedagogical principle. Further study and more experience, however, leads one to the conclusion that somewhere in the comparison there is a misinterpretation. The misinterpretation may be in our not knowing which is the fundamental and which is the practical, the reading or the spelling. It may be that they are both equally fundamental and practical and that the principle hinges on the question as to which is the more easily obtained and which helps more in getting the other.

In our opinion, if the comparison is carried far enough, we would see that the child has to learn to read a little and then learn to spell a little, and the first thing we know we are unable to tell whether he has to learn to read a little and then spell a little or whether he has to learn to spell a little and then read a little. And so if we apply the principle in the teaching of chemistry, we must think of what is the easier phase in chemistry and what will help more in developing the other phase. Maybe there must be a little of one followed by a little of the other.

F. S. Kedzie School Sci. and Math. 5; 309; 05 says beginners should have something practical and easy regardless of whether or not it is fundamental. He says, "Start the chemistry student by having him find the water in a piece of beef." We agree with this in part. We agree that the beginner should have

something easy, but why practical any more than theoretical, excepting possibly that for the first two or three exercises in the beginning course. Why should the beginners' experiments be practical at the expense of the fundamental? Why not both? We can hardly agree with the idea of giving the beginner the beef experiment. It is practical enough, but it is not easy for a beginner. It is easy for a beginner in physiological chemistry but for a beginner in general chemistry in an elementary course it is entirely too technical, also it has none of the fundamental elements in it.

Now as to whether the beef type of experiment is practical or not depends upon the angle from which we consider the practical. Beef is a familiar substance and we like to know how much of it is water, but the beginner in chemistry is not justified in taking the time required for the experiment in order to learn what little he would learn from it. The burning of a weighed amount of zinc and the weighing of the result of ash would not be quite so familiar but from a practical standpoint it would develop just as much skill in the manipulation of delicate apparatus (if the student is ready for that sort of thing) as the beef experiment and would teach a much greater fundamental principle. It would be just as easy, more spectacular, and would appeal more to the student's curiosity for the mysterious.

As a matter of fact, in elementary laboratory work, we are getting away from the quantitative experments, if we ever did have much to do with them, and starting the student on qualitative preparation of mixtures and compounds and observing differences, and on the preparation of elements and making compounds containing them and observing differences between the compounds and their component elements.

R. H. Bradbury, School Science and Mathematics 16; 769, 1916 in criticising the too great tendency toward the pactical, calls the practical advocate an, "Intellectual acrobat" trying to struggle into the spotlight by exploiting some stunt which happened to have caught the attention of the multitude."

It would seem from observations on the methods of instruction in various science that the spot light idea is responsible for the contention that students cannot be interested in laboratory work unless it is practical. In observing the attitude of students it can be noticed that they are too easily convinced that they should be interested in the spotlight phase of the sciences. They naturally make themselves interested in the things that

catch the attention of the multitude, because that can easily be taken as the successful.

It is nothing more than fair to the intelligence of the student to assume that he is watching the multitude to see what will catch attention. It is just as fair to the ambitious and intelligent student to assume that if he can be convinced by a far seeing teacher, (and all teachers should be prophets), that if something more didactic, and less spectacular, more difficult and less popular, can be made to serve as a foundation to a more lasting value in the distant future, he will cultivate an interest in that. The fact that a student is a student and not an apprentice, indicates that he is willing to cultivate interest in fundamental things, that he wants the theoretical so that he can get a better grasp on the practical It seems like discounting the student's interest in his own welfare to assume that lines of least resistance have to be followed in order to hold his attention.

It does not require a teacher of great strength to hold the interest of students by keeping before them the spectacular. The teacher of adequate qualifications, and abundant personal strength, able to convince students as to what is best for them never has trouble holding them to their work while they lay foundations.

We should assume that students want to do the right thing and we should pace the responsibility upon the teacher who is supposed to be their guide. Whether or not he can maintain most agreeable attitudes on the part of his students it is up to him to keep them hard at it in whatever is best for them in the future. Of course most workmen would rather put on frills on the side of the buildings next to the highway or build mantles and colonades in living rooms, than to dig into the earth and carry and pour sloppy cement for foundations to be covered up and put out of sight forever, but the master workman who knows what is required for architecture to endure, and beauty to be permanent, obtains agreeable cooperation if not delightful attitudes from his under workmen while footings and foundations are being laid.

If it should appear from these ideas that the student's attitude will be alright and that he cannot avoid being interested if the teacher can carry his own conviction as to what ought to be done, that is not correct. That would be giving the student credit for too much idealism and throwing too much responsibility on to

the teacher. The idea is that the teacher should be held responsible for making the student feel at all times that the manner of presentation and the material presented is the best for the student's interest. Then there will be as much interest shown to didactic fundamentals as there would be to spot-light practicabilities.

L. C. Newell, School Science and Mathematics, 7:169, 1907, in discussing the character of experiments for beginners, says the experiments should yield obvious results. This does not necessarily mean that the conclusions must be obvious. If conclusions were always obvious there would be no thinking for the student to do. This means that when hot charcoal is thrust into oxygen the reaction or the results of the reaction should be able to be observed plainly and without mistake as to what has happened. The "water in beef" experiment would not fulfill in this respect. Almost every phase of oxygen experiments would fulfill requirements in this respect. The simplest experiments with nitrogen, chlorine sulfur calcium, magnesium and iron also fulfill, but they do not all fulfill the requirement of being easy and familiar.

Hydrogen, phosphorus, potassium and sodium fulfill in this respect but they are dangerous to work with, and we run the risk of intimidating some students to such an extent that they acquire a distaste for the entire subject for all time by giving exercises involving these element in the beginning of an elementary course. Such students are not all of the female sex either. We know a young man, a courageous athlete, who had a scientific mind, who was enjoying chemistry immensely, but who upon a certain occasion got hold of some potassium and not knowing what it was, threw it in a water jar and caused such an explosion that he concluded chemistry was too treacherous for him. He changed his college course and would have nothing to do with chemistry thereafter.

Of course these dangerous things should be dealt with early enough in a course to ward against such accidents.

Newell goes on to say that the type of exercises to be chosen always depends on the several conditions.

1. Money available for supplies.
2. General equipment of the laboratory
3. The size of the class to use the supplies.
4. The work which the student intends to take up for life.
5. The place of chemistry in the curriculum.

6. The relative time devoted to experiments.
7. The time at the disposal of the teacher.

Newell also says that above all considerations the experiments must be of the kind which can be performed by the members of the class. If in some cases each is impossible, experiments should be chosen which may be performed by the instructor, but which call for much observation and calculations on the part of the students.

Newell says in a later article, School Science and Mathematics, 9:661, 1909, that the requirements in higher institutions should be a factor in determining the character of experiments offered to beginners.

No one would hesitate to say that this is the most important factor of all if in the first place all high school students intended to go on to college after completing the high school course and in the second place college teachers were better qualified to know what advanced students should have than are the high school teachers to know what the beginners should have.

In our opinion the first question is not as serious as most high school teachers take it to be, as far as laboratory work is concerned. Such matters can easily be adjusted by the college teacher if he finds duplication and that the duplication is doing harm than it is good.

In the first place repetition of laboratory work by a beginner in college is not as monotonous as is a repetition of text book work. The student generally is desirous of doing the experiments over. He feels as though he can really get the meaning out of them. If an occasional student feels like it is useless to do his elementary experiments over, that student is generally found to be an exception in chemistry and we can well afford to select for him a special list of more advanced experiments. Of if the regular college course contains a list of experiments more advanced than those generally used in the high school, and we have an occasional student who has not had high school work we can give him a list of experiments especially adapted to his need

It would seem as though it might be a great deal easier for the college to give different lists of experiments than it is for the high school to do so, if different lists are necessary. It really seems to us who have had experience in both high school and college teaching of the elementary work in chemistry that it is unnecessary to have different courses in the high school for those who expect to go to work at the close of the high school course

and for those who expect to go to college. This seems true especially for the laboratory work. As we have pointed out above, it is possible to make a list sufficient for a year's work of exercises, which have the easy to perform, the marked conduct, the obvious results and the familiar elements combined with the fundamental principles, all of which elements are good for both classes of students.

Since the study of chemistry has ultimately one or the other of two purposes to serve, that is to make a pactical chemist or to afford some general culture, the natural and proper sequence of laboratory work is: proving some general fundamental principles, making qualitative tests, and proving some quantitative relations. If perchance a high school student has the intention of making of himself a chemistry teacher, the above statement as to sequence is all the more important. To accomplish anything in the way of culture the mind demands some knowledge of general principles before it can do anything with qualitative relations organized and established before it can ever have an interest in quantitative relations. As to the case of making a practical chemist there ought to be no question as to the order of laboratory work.

If enough of these three phases of laboratory work could be given in one high school course to finish the training of a practical chemist, it would perhaps be alright to make one third of the laboratory work quantitative in character. Anyone who knows the situation will say that one year is not enough. They know that it is not enough because of their observations of successes and failures in the commercial work, but some will advocate the illogical sequence because they have found that from eighty to ninety-five per cent of the high school students never go on to college and thus enable themselves to continue in the proper sequence. Then the question arises, why do the thing wrong merely because we are unable to do it right? Is it because the word needs more practical chemists than we are able to put through college? If that ever was the condition, it is rapidly ceasing to be. The managers of industrial concerns are finding that there is no permanent profit in having one well paid college trained master, and with him a half dozen or more cheap, incapable routine "recipe" followers, as has to be the case with such a proportion of high school trained workers. As chemistry becomes more and more in demand, calling for more and more men, the managers and owners of industrial plants are financing

the college training of certain promising young men, either from their own personal funds or from funds established by the company for the purpose. Many commercial organizations are furnishing colleges and universities funds to establish scholarships and fellowships to induce prize winning students to continue in certain fields of chemistry.

A few years ago when the practical in high school laboratory work was advocated most strongly, we heard a certain college professor of chemistry in an educational meeting scold long and hard because his students who had come from the high schools could not give the details in the directions in the Solvay Process of making sodium carbonate in such a way that they could be applied, and sodium carbonate would be turned out on a commercial scale.

That sort of thing seemed different from what most college and university professors advocated, for most of them charged the high schools with trying to be too practical. To us, that seemed to be trying to impose entirely too much of the practical on the high schools. We liked the idea of requiring high school students to make sodium carbonate by the Solvay Process, sufficient to test and find that some really had been made. However, we liked the student to know the high points in the procedure only sufficiently to interest him in the reactions, and to lead him to the working out of the equations.

William Congor Morgan, School Science and Mathematics, 8; 645, while emphasizing the call for men today "who can do, who can see, who can solve problems of life, * * * who are thinking, feeling, and willing beings, * * * men who can use tools," mentions several laboratory experiments which have the tendency to develop such things. He lists the burning of lime, the slacking of lime, the making of mortar, the making of plaster of Paris, the distillation of coal, the making of white lead, chrome yellow, and Prussian blue. We notice that any good laboratory manual has all of these, but we feel like taking the student far enough into the details of such experiments only to show how chemistry is related to the practical and how to show that the fundamentals are essential to these practices, enough to show how fundamental chemistry applies to agriculture and the industries, not sufficient to make a student think he is a technician.

Starting the student in the laboratory with what appeals to him most is almost like what is advocated by some inexperienced

high school teachers, that the student should himself select his experiments, devise his own method of attack, and go the way that seem to interest him most.

This is research, pure and simple, with the emphasis on the simple. We are willing to confess that such a scheme is very pleasing to the student, and seems both to the student and teacher to be profitable, but if it does not spoil the student permanently, it is a waste of time. We should say that such an order nullifies any chances for the student to make the best of himself. It ruins him mentally if it does not blow him up physically. We have never been able to do anything in college with a student who has been so treated in the high school. It is impossible to get him interested in anything that is deeply fundamental. He cannot stay by a problem which takes time and patience. His tools are simple, his field of operation is small. He soon covers it. He may reach the top in his type of work. He may even make a fortune by inventing a shoe button, but he can never hope to make a chemist.

R. H. Bradbury in School Science and Mathematics, 17; 25, 1917, condemns the above sort of scheme in the following terms: "We are all acquainted with the futile and dangerous tomfoolery of the pupil who starts to investigate on his own account." He says too that this sort of thing delays needed reform and development. Bradbury advocates a systematic scheme with fundamentals first, but he says to start each topic with something concrete.

Frank B. Wade School Science and Mathematics, Vol. 20; 313, (1920) gives expression to what seems to be the proper attitude toward the relations of the practical and fundamental. He refers to these, however as the special and the general. He has made some observations on his chemistry students after they have gone from the high school. He says that not more than five per cent of his chemistry students ever used their chemical knowledge for gain, but a large per cent became chemists after going to college. He says also that the high school students who did become chemists had very diversified work to do and it would have been folly to have given them any thing but general training. He observes too that the student given general training is advanced faster in a technical laboratory than one who is given special training. Wade tells this experience which is strong evidence in favor of the assertion. He says he organized in his high school a vocational chemistry class for students who

had finished the elementary chemistry and showed ability in chemical technique. The course was offered for the sake of some industries in which some simple routine work by assistants was desired. These industries were asked to suggest as to what should be given. Some of the suggestions were as follows:

1. Teach them to think chemistry. We train them in the specific routine.
2. Teach them to have respect for figures; to be honest with data; never to doctor results.
3. Teach them to clean their glassware.
4. Teach them to be rapid and accurate in their manipulations.

If this latter statement seems contradictory to any of our former statements in which claimed that the beginner dare not try to be too rapid, we must remember that we were advocating placing the emphasis on accuracy first and that for the beginning course which these students were supposed to have finished. We note that even though these students had had their fundamental course, they were advised to take what would make them think chemistry and leave the technical to be given in the industrial laboratory into which they went to work.

Regarding time given to laboratory work and number of experiments required, J. W. McDonald, Massachusetts State Board Report for 1907 says: "Too much time is given to so-called laboratory work with elaborate and expensive apparatus. Too little attention is paid to simple and effective illustrations of simple phenomena and simple applications of fundamental principles to be foind in every schoolroom and its immediate environments. This is true if applied to some sciences, especially if we place the emphasis on the expensive apparatus and the every day experiences used as laboratory study. The only way such pedagogy could be applied in chemistry would be to use an example like the furnace fire with its necessary supply of air and its ashes as a laboratory study of oxidation. In this, if we undertook to pass from the familiar to the unfamiliar, we would soon involve complications and expense. The inexpensive modifications of such appliances would bring us to what is above advocated.

With such things in mind, one must conclude that the teacher who advocates the practical at the expense of the theoretical or fundamental is doing one or the other of the following unprofessional things: he is confessing that he thinks the foundations

of chemistry are so difficult that a sufficient number of workers in the field for the world's welfare will be unable to pursue the subject, or he is discrediting the intelligence of young people by claiming that they cannot be interested unless they are started out in the "Spotlight phase" or the "immediate results branch" of the subject, or he is contending that a smattering of methods of following recipes is the better way to develop general culture in a young person, or he is trying to popularize his subject and induce large numbers into his classes for the sake of his own glory.

SCIENCE CLUBS IN THE HIGH SCHOOL.

GUY M. SMITH

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That there has been a great change in our schools in the last few years regarding science, no one will question. It was not many years ago that the student first came in contact with scientific knowledge in his college course. Today all this is changed. The science course has stepped down into the high school, and as General Science we may say, not only stepped down into the high school, but into the upper grades of the elementary school. As our modern civilization reflects more and more the results of scientific thinking and investigation, must not our school program give a larger place to proper scientific work? The student is not educated who goes through life unmindful of those things of the world which are about him every day. If the school can encourage the child in his native curiosity—about the earth, the trees, the rocks, the sky,—all these things, and also man-made machinery, it has done something for the individual. When a better understanding of some of these things is gained, life will mean more. As a means to this end, has the science club a legitimate place in our high school life, and can it be made a means of service to the students? We wish to report on what the present situation in our high schools seems to be, to offer a few suggestions as to what may be done, and to give illustrations of what in some instances has actually been or is being accomplished through such club organizations.

In order to gain some idea as to how many high schools might have a science club in their school activities a small survey was made. The unit taken for this survey was the Northern Illinois State Teachers Association. This association includes nine counties of northern Illinois and is represented by fifty-seven high schools. While it is known that this is a small unit and the

results obtained may not be very significant, yet on the other hand, the data gathered may be typical of any or all such school units. From the fifty-seven questionnaires sent out, forty-three were returned. These replies came from schools varying in size from twenty-three pupils to over twenty-three hundred pupils. Several of the schools were community high schools—some were township. From the forty-three schools represented only six reported as having science clubs although all were giving some work in science of one kind or another. In terms of percent this would show that about 13.7 per cent of the schools making a reply, had a science club, but of the total number of schools in the unit, only 10.5 per cent reported a club.

Only two schools submitted reasons for not having a science club. The principal of a school of seventy pupils, sixty-five of whom studied science, gave as a reason the fact that since most of the students came from rural districts, it was thought best to limit the number of outside activities. The head of the science department from a school of eight hundred pupils with three hundred enrolled in science classes expressed disfavor for science clubs, as experience had shown that the chief advantage was mostly advertisement, and as far as actual work accomplished it could be done just as well—if not better—in the classroom where all could get the benefit, rather than in a club where the chief good would come to only a chosen few.

The type of club and the work attempted in the schools reporting organizations showed quite a variation. One school has a Radio Club of twenty-five boys; another the Home Economics Club for girls, and the Agriculture Club for boys. Two schools report the Science Club with no restriction as to membership. A Junior High School has the Nature Study Club for both boys and girls. The largest school in the unit reports five clubs, each one representing in a large degree a specific type of work.

Can a program for science clubs be outlined that will justify their position in a high school? Is it too much to ask that the work be along both social and educational lines? Is there a work of value to be done in a club that cannot be accomplished in a science class? The schools of today must send out boys and girls trained to be leaders in the world of tomorrow. The meetings of the club give the students an opportunity to meet and get acquainted with one another. This is especially important in a large school. It is a help to school spirit to have the students acquainted with each other. The officers have certain duties

to perform. They will realize that they must do these things or the whole organization will suffer. The fellow students have elected them because they believed in them. They feel an impetus to make good. The programs for the most part are to be given by the students. Here the students will receive training along various lines. If they are to appear on the program they must be prepared and ready to do their part and appear well before their associates. They will learn to share responsibility, to do their part of the job, carry through the project they have started, or think through a new one. Who can say that such work is not worth while? The work will not always be the same. Now and then an outside speaker of note may be called in. This will tend to give the students greater vision. The programs must vary to keep up interest. But with wise and careful faculty supervision this can be done and each member may derive the maxmum of good.

To leave the field of speculation let us see what one school has done and is doing with her science clubs. Rockford High School with an enrollment of 2,370 students has five distinct clubs in the science department. Four of these organizations do specialized work, one work of a general character.

The Wireless Club has been in existence since 1907. This club is for boys only. Its meetings are held each week on Monday afternoon and on Friday evening. The programs are always helpful and interesting. At the Monday meetings topics of current interest and importance in this field are considered. This group has recently constructed a 50-watt transmitting set and this particular phase of the work is taken up at the evening meeting. The treasury of the organization is increased by building receiving sets which have been sold. Here we see a coordination with the work in the wood shop. Problems regarding school life are part of the work—at present the matter of placing amplifiers in the school auditorium is a project being considered.

The Biology Club is another of the older clubs. Both boys and girls may join. At present there is a membership of nearly sixty-five students. The programs consist of talks, discussions, papers, also music and games. When weather permits field trips are made. A picnic is an annual event. The individual members work out projects for the school and even the community—trees in the yards of the city's public schools are classified and labeled—these and numerous other similar projects carried through every year make the work of the club decidedly worth

while. From the membership of this club have gone several young men and women who today are out in the world doing splendid and creditable work along biological lines. Who dare gainsay but that it was at the meetings of this organization, or while working on a project for presentation before the group that the student caught the vision and was inspired to go on in the work. The club as a unit is buying two seats in the new Stadium. From the field trips and excursions many snapshots are secured for the school Annual. These things all add interest and make for the proper school spirit.

The Agriculture Club is only for the boys taking agriculture. This club promotes the interests of agriculture and is both a social and an educational organization. Officers are elected by the members. Meetings are held every two weeks and varied programs are presented. Agricultural speakers of note frequently address the club. The boys have debates; rural plays are sometimes given. In the Fall and Spring the meetings are often held at the farm home of one of the members. A Father and Son banquet given by the boys to their fathers is an annual event. Here the club is doing a real service in linking the school with the home and the life of the community. Enough money is raised by the organization each year to defray all expenses of the Stock Judging Teams.

The Camera Club is open to all students interested in photography. From an educational viewpoint the work consists of study of the chemistry of photography; in the taking and enlarging of pictures; colored photography, and also the composition of pictures from the artistic side. Hikes and feeds furnish the social side of the work.

The youngest organization in the school is the Pasteur Club. This organization allows only Freshmen boys and girls in its membership. The work attempted here is purely in the field of general science. The students furnish the programs of experiments, papers, and discussions, music and games. On hikes and field trips those with cameras often take pictures illustrative of some part of the class room work. These pictures are enlarged and used in the class room. Scientific plays are written and given by the students. Outside speakers are at times asked to address the club on some interesting topic. This group has a more general type of work since the student in his second year is eligible to the other clubs which have a more specific work. By means of this club the young student is given a new interest

in his science work and in his school life in general. He has an opportunity to receive training as he comes in contact with fellow students and in the second year is ready to continue his work in one of the other organizations of the school.

It seems to be quite evident that there is a real value in science clubs in the high school. There is a supplementary work which can be done in the club which cannot possibly be done in the class room. The work of the club is not only valuable from an educational viewpoint but it has a real social value as well. The percent of schools using the science clubs as a means for more effective work in this field is much too small. By continued effort along this line the work of the science class room can be made much more effective and its value increased both for the student himself and for the community.

THE ARTICULATION OF GENERAL SCIENCE WITH THE SPECIAL SCIENCES.[1]

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The Object of This Investigation

The purpose of this work is an attempt to find just where general science fits in with the sequence of science work as it is being developed in the high school. General science has made rapid progress and it is interesting to know why general science is occupying first rank as a science course. It is crowding out many other sciences that were once considered important.

Before taking up the articulation of the subject matter, the aims and progress of general science will be considered. The aims of authors and writers will be summarized as well as the opinions of teachers which have been gathered by questionnaires. In the progress of general science we can see what place general science is trying to fill in the curriculum.

The chief task in the problem of the articulation as here reported consists of finding the relation of the subject matter of general science texts to those of the special sciences, physics, chemistry, biology, zoology, botany, physiology, and physical geography. Then knowing the articulation of the subject matter it will be interesting to see how the general science course articulates with the other science courses. These two types of articulation should work together in a well organized system,

[1](The thesis from which this article is taken covers 133 pages. Many tables and explanations have been omitted. The summaries and conclusions are given. The thesis was written for the Education Department of Wisconsin University under the supervision of Professor W. L. Uhl.)

and the following summary will give the material available for this discussion.

The analysis of the textbooks took several months of work, for it covers thirty-one books which total 14,524 pages. These pages are listed under 861 different topics which occur in Table where all the sciences are tabulated together to show how they articulate. No effort was made to classify any topic which occupied any space less than one-fourth of a page in any of the books. In the entire work any page or part of a page was entered only once under some topic where the writer seemed to think it belonged. It may be mentioned here that this was a difficult task. To illustrate, I may take oxygen as an example. It depends upon how it is taken up as to where it should be assigned. It may come under combustion, oxidation, air, or oxygen itself, so if anyone else had analyzed the books there might be a slight variation. At any rate it does not transfer the pages to another special science, so the final outcome is the same regardless of under what topic it may be assigned. Several attempts were made before a system was worked out by which the topics could be arranged and no losses or duplications become registered. The illustrations in the texts were analyzed with the material and counted as such if they were good in explaining the topics.

In the selection of the texts to be used in the analysis, lists were obtained from representatives of the larger publishing houses which ranked the most used books of all the publishing companies. By using these lists and checking their result with the writer's ten years of science teaching, the following books were chosen and analyzed:

Physics

Millikan & Gale, *Practical Physics.*
Dull, *Essentials of Modern Physics.*
Carhart & Chute, *Practical Physics.*
Black & Davis, *Practical Physics.*

Chemistry

Newell, *Practical Chemistry.*
McPherson & Henderson, *Chemistry and Its Uses.*
Brownlee & Others, *Elementary Principles of Chemistry.*

Biology

Moon, *Biology for Beginners.*
Smallwood, *Biology for High School.*
Hunter, *New Essentials of Biology.*
Peabody & Hunt, *Biology & Human Welfare.*
Gruenberg, *Elementary Biology.*

Zoology

Linville & Kelly, *A Text Book in General Zoology.*
Hegner, *Practical Zoology.*

Botany

Bergen, *Practical Botany.*
Coulter, *Elementary Studies in Botany.*

Physiology

Conn & Buddington, *Advanced Physiology and Hygiene.*
Walters, *Physiology & Hygiene.*

Physical Geography

Dryer, *High School Geography.*
Salisbury & Others, *Modern Geography.*

General Science

Barber, *Lessons in Science.*
Snyder, *Everyday Science.*
Hodgdon, *Elementary General Science.*
Tower & Lunt, *The Science of Common Things.*
Webb & Dideoet, *Early Steps in Science.*
Caldwell & Eikenberry, *Elements of General Science.*
Hunter & Whitman, *Civic Science in Home and Community.*
Van Buskirk & Smith, *The Science of Everyday Life.*
Trafton, *Science of Home and Community.*
Smith & Jewett, *Introduction to the Study of Science.*
Fall, *Science for Beginners.*

The Aims of General Science

Most of the important aims of General Science are presented by the authors of four recent texts which will be quoted first before giving summarized reports.

Caldwell & Eikenberry in the preface of their 1924 edition, *Elements of General Science,* state that, "Human experience includes results of modern science almost constantly. It is the object of this course to develop a usable fund of interesting and worth-while knowledge about common things. It is also its object to develop helpful and trustworthy habits of thinking about and of judging the common experiences which fall within the field of science. Particular interests and abilities of pupils are frequently revealed in science studies, and by recognizing and directing them more effective and profitable work may be accomplished in vocations or later studies."

Tower & Lunt in the 1922 edition of their book, *The Science of Common Things,* make this statement to the boys and girls that study the book, "The *Science of Common Things* gives you many interesting and worthwhile experiments about matter directly connected with your daily life, so that you will have a better understanding of what is going on about you. We want you to learn and observe closely, to think carefully, and to draw natural conclusions from the results of your experience. If you succeed in gaining these habits, you will be happier and much more successful all through life."

Hunter & Whitman in their 1923 book, *Civic Science in Home and Community*, state that, "Most of all a text book should interpret to the child the part played by the various natural factors in their environment. It should conceive the child as a center, with all the world revolving around it. In this conception boys and girls become aware of the vital parts played by air, water, light, heat, and food on them as individuals within their homes.

Webb & Didcoct in their 1924 book, *Early Steps in General Science*, state that, "The true purpose of General Science is to create a preliminary wide-spread interest in science as a thing of Personal importance. Its study should increase the enrollment in the more advanced science classes for it will remove that ignorance concerning the general nature of science which, as every science teacher knows, causes many students to hesitate before entering the more specialized courses.

Mr. Wallace H. Kiang who in 1924 wrote his Doctor's Thesis at Wisconsin University on the "Derivation and Development of Criteria in General Science," has the aims of forty-three authors and writers well tabulated. Summarized they rank as shown in table I. The figures indicate the number of authors and writers mentioning the listed aims.

Table I

The Aims of Authors of General Science Textbooks.

Better understanding and control of environment	28
Information about nature and science	23
Preparation for later science courses	19
Training in scientific methods	16
Development of power of interpretation and appreciation	14
Development of interest in science	11
Culture	10

Mr. Kiang sent out a questionnaire to the teachers of Wisconsin teaching general science and received 117 replies. Of this number, 95 reported that the primary aim of general science is to familiarize the pupil with his environment. Howe and Miller who made out similar questionnaires covering more territory found that the understanding, appreciation, and control of environment was the chief aim of general science. Five men[2] have sent out questionnaires to teachers and their findings are shown in table II.

[2]Roecker, W. F. "An Elementary Course in General Science."
School Science and Mathematics, 14:755-69
Worun, A.A. "General Science in Michigan."
General Science Quarterly, 2:267-84
Howe, M. C. "Can and Should General Science be Standardized?"
School Science and Mathematics, 19:248-55
Miller, C. F. "Survey of General Science Situation in Illinois."
School Science and Mathematics, 19:398-408

Table II
The Aims of Teachers of General Science

Aims	Roecker	Worun	Howe	Miller	Kiang	Tota
(Approximate year of report)	1914	1917	1918	1919	1924	
(No. of replies to Questionnaire)	50	101	80	81	117	429
Understanding of Environment	.....	31	53	38	95	217
A fund of valuable information	33	19	12	18	.....	82
Preparation for later science	31	47	6	11	9	104

Summary of Aims

Space does not permit quoting in detail the findings of these men, but it is rather interesting to note the aims of general science as it is getting more firmly established. The early investigations seemed to put the chief emphasis on the preparation for later science courses, while the present investigations clearly show that to understand and control environment is the chief aim of general science.

The aims of authors, writers and teachers can be ranked about as follows.

1. Understanding, appreciation, and control of everyday environment.
2. A fund of valuable information which can be applied to one's industrial and social life.
3. A fund of valuable information about nature and science.
4. A preparation for later science courses.
5. Develop the ability to think clearly and interpret correctly.

(Many others of less importance may be mentioned.)

The Progress of General Science

General science really had its present beginning about 1905. In J. E. Stout's report, "Development of High School Curriculum in the North Central States from 1860-1918," published by the University of Chicago Press, we note that from 1871-1875 about 5% of the schools offered natural science. This was due to Mr. Kiddle, Superintendent of New York City, who had a course of what might be called general science put into their system which was followed by other schools, but it died out as he and those interested in the work left the city schools. In 1884 the United States Bureau of Education sent out a bulletin encouraging science work. Shortly after this and during this time, certain persons were very enthusiastic about special sciences for the grades. Physics was the book used in this grade work more than any other science text. Out of these elementary texts some of the authors got the idea of having several sciences included in one text but it is noticed that they always laid special stress on the particular science in which they were most interested and that was generally the science he taught in college or university. It is on account of such books that the criticism is made that we have no well balanced books. From the beginning of special sciences for the grades we have come all the way

to the present texts which have the work just about evenly divided, with special emphasis put on the sciences that explain one's everyday environment. Up to date there have been forty odd books that have come from the press that have been named general science texts.

It is interesting to note that in the early investigations of general science, the course was not planned for the convenience and need of the pupil but for the convenience and accommodation of the teacher. It was an extra subject that was tacked on to the special science teacher and in some cases given to a teacher that knew very little about any science. These teachers of course would choose the text that fell in their particular line of work, for the physics teacher would select a physics book just as the biology teacher would select a book that had much biology in it. Time has changed this attitude until today we realize that the general science course must be planned to suit the need of the 13- or 14-year old child and taught by a teacher who can adapt content and procedure to the level of the thinking ability of the boy or girl of that age. It has also become known that many of the special science teachers are poor general science teachers. A teacher must have had some of all the special sciences in order to be a good general science instructor, and we now have some schools that are giving such instruction to prospective general science teachers. With the last few books published, and the latest instruction given to the teacher concerning general science teaching, the course in general science has become attractive and would hardly be recognized by the teacher of ten years ago.

The U. S. Bureau of Education reported for 1921-22, page 19, upon an investigation which showed the enrollment in different science courses in schools of over 100,000 population. This enrollment is expressed in percentages in table III.

Table III

Enrollment in Cities of 100,000 Population

Science	Percent of H. S. pupils enrolled	Science	Percent of H. S. pupils enrolled
General Science	14.84%	Hygiene & Sanitation	11.71%
Physics	8.59%	Physiology	4.61%
Chemistry	8.88%	Physiography	2.68%
Biology	8.96%	Geology	.17%
Zoology	1.23%	Agriculture	.27%
Botany	2.89%	Home Economics	12.47%
Electricity	.23%	Astronomy	.10%

Table IV

The Changes in Science Enrollment in Minnesota for the five-year Period from 1915 to 1920

(+ indicates gain; — indicates loss.)

Subject	Total number *students* *1915-1920*		Percent of total *enrollment* *1915-1920*		Percent of gain or loss *in 5 yrs.*
General Science	458	5684	1.2	11.5	+858.3
Physics	3865	3835	10.0	7.8	— 22.0
Chemistry	4293	4790	11.0	9.7	— 11.8
Biology	675	889	1.7	1.8	+ 6.0
Zoology	2275	1450	6.0	2.9	— 52.0
Botany	3981	3072	10.0	6.2	— 38.0
Physiology	3095	3082	7.5	6.3	— 16.0
Physical Geog.	3264	2092	8.0	4 2	— 47 5
Total in State	39520	49060	Percent gain		24.1

In *School and Society, 16:* 367-71, James and Wipperman have an article on, "Science in Wisconsin High Schools." They obtained the data shown in Table V from 100 high schools giving a four-year course, 50 of which represented Agricultural High Schools and 50 non-Agricultural High Schools. It was found that the special sciences ranked a little higher in the Agricultural schools than in the others. The data are given in percent and one can readily see that since most high schools require 16 credits for graduation, a percentage of 6.25 will represent one credit. If a subject has 6.25 percent, it means that it must have been required.

Table V

Subject Enrollments in 100 Wisconsin High Schools by Percentages.

Science	1901	1911	1921
General Science	.00%	1.11%	5.65%
Physics	2.94%	3.56%	2.78%
Chemistry	.20%	.86%	1.69%
Biology	.00%	.00%	1.54%
Zoology	.31%	.26%	.24%
Botany	4.49%	3.38%	.87%
Physiology	4.18%	3.40%	1.79%
Physical Geog.	6.25%	4.39%	.48%
Total Sciences	18.37%	16.96%	15.04%

Gains		Losses	
General Science	5.65%	Physical Geog.	5.77%
Biology	1.54%	Botany	3.62%
Chemistry	1.49%	Physiology	2.39%

Dr. Stout of Northwestern University chose forty schools which represented the states of South Dakota, Ohio, Michigan, Missouri, Illinois, Indiana, Nebraska, Kansas, and Iowa. He compared the subjects offered from 1906-11 with those offered from 1915-18. Table VI indicates the number of the forty schools offering these sciences.

Table VI

Sciences Offered in 40 Schools That Stout Investigated

Subject	1906-11	1915-18
General Science	1 or 2.5%	19 or 47.5%
Physics	40 or 100.0%	40 or 100.0%
Chemistry	37 or 92.5%	37 or 92.5%
[3]Biology	7 or 17.5%	18 or 45.0%
Zoology	22 or 55.0%	16 or 40.0%
Botany	34 or 85.0%	27 or 67.5%
Physiology	26 or 65.0%	21 or 52.5%
Physical Geography	33 or 82.5%	21 or 52.5%
Astronomy	5 or 12.5%	1 or 2.5%
Geology	4 or 10.0%	3 or 7.5%

The writer of this article thought that Dr. Stout's investigation ought to be carried on to the present date. On Nov. 28, 1924, therefore, a letter was written to the same forty schools asking for the enrollment in the sciences mentioned above. The enrollments include only senior high schools or regular high school students. Those offering the courses include junior high school data only if such data were voluntarily given for the letter did not call for such data.

Table VII

1924 Enrollment in 34 of the 40 Schools in Stout's Investigation

Subject	*Enrollment*	Number of Schools *offering the course*
[4]General Science	3172	30 or 88.2%
Physics	2918	34 or 100.0%
Chemistry	2729	33 or 97.0%
Biology	2876	25 or 73.5%
Zoology	357	6 or 17.6%
Botany	743	13 or 38.2%
Physiology	760	16 or 47.0%
Physical Geography	1071	12 or 35.2%
Astronomy	0	0 or .0%
Geology	0	0 or .0%

Table VIII

Summary of Forty Schools, Covering Dr. Stout's Work and the Later Investigation

(The table gives the percent of the schools offering the different sciences.)

Subject	*1906-11*	*1915-18*	*1924*
General Science	2.5%	47.5%	88.2%
Physics	100.0%	100.0%	100.0%
Chemistry	92.5%	92.5%	97.0%
Biology	17.5%	45.0%	73.5%
Zoology	55.0%	40.0%	17.6%
Botany	85.0%	67.5%	38.2%
Physiology	65.0%	52.5%	47.0%
Physical Geog.	82.5%	52.5%	35.2%
Astronomy	12.5%	2.5%	.0%
Geology	10.0%	7.5%	.0%

Gains in Percent		Losses in Percent	
General Science	85.7%	Zoology	37.4%
Chemistry	4.5%	Botany	46.8%
Biology	56.0%	Physiology	18.0%
		Physical Geog.	47.3%

Lost as High School Subjects in 1924

Astronomy Geology

[3]Biology became a high-school subject between 1896-1900.

[4]In response to the question, "Is general science required?", 12 answered yes and 21 no.

In glancing at the tables it is interesting to note that general science is now the most widely taught science in our curriculum. It has gained rapidly and its gain can be accounted for in the losses chiefly of physical geography and physiology. Biology has made rapid progress in becoming established as a high school subject, but its gain has not been as rapid as that of general science. The gain in biology is mostly responsible for the losses in botany and zoology and somewhat in physiology. Zoology and botany have dwindled down rapidly except in the larger schools where it seems to be more convenient to teach them than biology. In some cases, however, it is because they offer more specialized courses.

General science has been taught in the ninth grade more than in any other grade because it had its beginning in the 8-4 plan and most of the schools are still running under that plan. Where the junior high school plan has been adopted, we find that the eighth grade is the best year for introducing general science. In Kiang's investigation in which 117 teachers designated where general science should be taught, 55 indicated eighth grade, 47 indicated ninth grade and 15 indicated seventh grade.

THE ANALYSIS OF SUBJECT MATTER IN TEXT BOOKS

In the analysis representative books were analyzed and in each subject the pages were averaged so that we might know the contents of an average book. These average books were used in the final articulation of the subject matter. This articulation contains 861 topics. Lack of space does not permit the printing of individual tables for each science or the articulation. Samples of two special science tables and the articulation will be given in Table IX so that it may be clear how the results were obtained.

The Analysis

The letters A, B, C, etc., represent different texts in the subject analysis and in the articulation they represent the different sciences, physics, chemistry, biology, zoology, botany, physiology, physical geography, and general science. The data under these letters give the number of pages on each topic listed in the respective books. The last column in each table show the average number of pages for each topic in the different sciences which are used in the articulation of the subject matter.

Table IX

1. Biology

Topics	A	B	C	D	E	Av. pages
Absorption	1	2¼	¾	1½	3	1.7
Alimentary canal	6	4	5½	4¾	4	4.9
Amoeba	1	3	2	3¼	.....	1.9
Ants	.....	2	1	.....	1	.8

2. General Science

Topic	A	B	C	D	E	F	G	H	I	J	K	Av. pages
Air	3½	.....	¼	7	.....	3	3	3¼	1¾	3½	2½	2.52
Air Composition	.....	3	.....	1	1½	1¼	½	¼	.....	½	3	1.
Air Pressure	8½	7	10	4	3	5	3	3½	2	5¾	3½	5.02
Alimentary canal	1	.....	1	.....	1	¼	1¼	.....	.....	.....	.....	.44

3. The Articulation of Subject Matter

Topic	A	B	C	D	E	F	G	H
Absorption, foods	.....	.....	1.7	.....	.....	3.0	.....	.04
Air Pressure	24.2	.....	.2	.....	.....	.....	4.0	5.02
Alcohol	.....	2.7	13.7	.....	.....	7.3	.....	1.94
Alimentary canal	.....	.....	4.9	.....	.....	3.5	.....	.44
Bacteria	.....	.....	7.6	1.1	10.2	.....	.....	7.5

4. Summary of the Articulation

Science	Pages in av. text	Pages of av. Gen. Sc. falling under	% of av. Gen. Science falling under	% of av. Special Sc. covered by av. Gen. Sc text
Physics	427.39	177.32	32.4%	41.4%
Chemistry	417.5	104.38	19.1%	25.0%
Biology	446.7	154.52	28.3%	34.5%
Zoology	422.6	32.79	6.0%	7.7%
Botany	453.4	78.69	14.4%	17.3%
Physiology	363.5	74.57	13.6%	20.5%
Physical G.	415.7	119.47	21.8%	28.7%
General Science	546.13			
Total		741.74		

The total pages of general science listed under all the topics when checked with each special science separately are 741.74. The average general science text only contains 546.13 pages. This means that 741.74 pages minus 546.13 pages give 195.61 pages that must overlap in two or more subjects. There are 93.92 pages of biology that overlap with zoology and botany as one would expect. There are 60.54 pages of biology that overlap with physiology, and 18.06 pages of physics that overlap with chemistry. Only 23.09 pages remain to be accounted for in the overlapping which may take place in the remaining sixteen ways that the special sciences may be paired.

Since we know the number of pages of general science that fall under each special science, we can in the third column express the percent of general science that is each of the special sciences. Assuming that a page of general science is equivalent to a page

in the special sciences, we can in the last column express the percent of the special science that is covered by the average general science text.

The Conclusion.

General science is now required in many of the schools. Most states require physiology and hygiene to be taught but these requirements are being fulfilled in many places by a portion of general science or biology. The average general science text contains 74.57 pages of physiology and hygiene. The average biology text contains 60.54 pages of physiology. These pages are sufficient to meet the state requirements when taught with the related topics on community life found in either the general science or biology texts.

General science should be required of every pupil going through the ninth grade of the high school. Should the pupil drop out of school following the ninth grade or take no more science during his high school course, he has at least had the fundamental principles dealing with his environment and has gained valuable knowledge concerning nature, himself, the home, the community, and some of the industries where he finds employment. No other subject can give the boy or girl who quits school as much usable knowledge as general science in the time that is given to its teaching. On the other hand, should the pupil continue through the high school, he will have the elementary fundamentals of the special sciences and can continue in biology, chemistry, and physics just where he quit in the general science. By this articulation the student will complete more work in these special sciences, and at the same time through the general science get all the fundamentals, principles, and facts in physiology and physical geography that a person will retain and use. Much of physical geography is not interesting to the stident as he feels no need for it in life. The important things, such as the atmosphere, weather, storms, erosion, etc., are found in the general science books.

The trouble with the science course in the high school today is simple. In most cases the sequence of subjects is worked out but the teachers do not know exactly what has been taught the pupils before they come to the special science classes. Each teacher begins, therefore, with the preliminary things, generally to accommodate a few who did not have general science where those things were taught. According to the articulation of subject matter, the majority of the class who took general science

will shirk on the job for they have already had 34.5% of the biology, 25% of the chemistry, and 41.4% of the physics that is being offered by the teacher. That is enough to make many of our best students lazy and careless and it is because of this lack of articulation that spoils the interest of many students. This explains why many general science students do poorer work in the special sciences than those never taking general science. The subject is taught for the interest of the non-general science pupil.

If the school system is on the 8-4 plan, then general science should be taught in the ninth grade of the high school. In most cases where general science is taught in the eighth grade under that plan it is poorly taught, because the teacher is not prepared to teach it and therefore the pupils get very little out of the course They will have to take it again in the high school.

In the junior high school, general science may be offered in the eighth or ninth grade. Experiments by H. A. Webb prove that the seventh grade child is not able to grasp many of the principles of science and can not reason well enough to solve many of the problems involved. Being in the junior high school, the equipment and teacher ought to be adequate to teach the subject. Where general science is offered only two or three times a week, very little is accomplished. The interval of two or three days between recitations loses many of the facts gained in the previous lesson and to get their connection, part of the following period must be used to bring them back. Such an arrangement can not be considered a good course, although the subject may run over a period of two years.

The ideal plan under the 8-4 plan would be to give general science in the ninth grade, biology in the tenth, and physics and chemistry the last two years, preferably chemistry first. General science should be required. Then those electing any or all of the special sciences can continue where they left off in the general science and thus cover far more work than under the old plan where every science is taught separately as a unit by itself.

In the junior high school system, general science should be taught in the eighth or ninth grade. If taught in the eighth, biology may follow in the ninth. The tenth grade will be vacant as far as science is concerned, thus giving a year for other work. The last two years should again be given to chemistry and physics. It is best to follow general science at once with biology if it is to be given.

If there are still some schools that do not give the general science course, then of course physiology must be taught. A whole year will hardly be necessary, so the best plan is to teach physiology one-half of the year and during the other half teach physical geography. A half year is sufficient time to cover either one of the subjects. Biology, chemistry and physics may follow, but under this plan no introductory work has been given in these subjects, so each has to be taught from the beginning. Under the general science plan, the time spent on preliminary topics can be used on advanced work.

The biology, chemistry, and physics texts today contain so many facts that it is hard to complete them in one year. It is easier to omit some topic in biology and in chemistry than in physics. In physics the facts stand out so conspiciously that it is hard to omit them without someone's noticing it. With the new developments of the automobile, airplane, radio, and others, it is very hard to cover every topic as the text is getting too large. Taking the elementary principles in general science allows plenty of time to cover all the topics thoroughly in the physics course. The same is true of the biology, but it is a comparatively new subject and should a teacher omit part of the work it would probably pass unnoticed. In this conclusion the term biology may in a few cases be interpreted zoology and botany but in most cases biology is meant. One year of biology is a far better course than one half year of zoology and the other half botany.

It will probably be a long time before there will be a standard course in general science. The chemistry course, although belonging to an old science, has not yet been standardized. In that same sense there will probably never be a standard course in general science, although in the analysis one finds that the recent books contain closely related topics and thus approach nearer a standard course. From experience it may be known that the course will never be uniform because the different sections of the country and city will put emphasis on different topics. However, each school should have a well outlined science course that runs through the high school. It should not only arrange the sequence of science subjects but arrange a sequence of the content that is to be offered in the high school, if the course is to be good. The recent check on the curricula show the sequence of the subjects to be quite definite in part of the schools. General science has made rapid progress as a course so that now

it is offered in practically every school. If it is not offered in the high school, it is offered in the junior high school or the grades. Biology has grown almost as fast and is now offered in about three-fourths of the schools. As these two subjects have gained prominent places in the curriculum, physical geography, physiology, zoology and botany have lost their prominence as none of these is now offered in half of the schools. Reference to the tables will give their exact standing. Some of the schools have passed through the transition period and discarded the physical geography, zoology, botany, and physiology courses. Others are in the transition period and are really teaching both systems. A few adhere to the old system of science teaching. General science has had a good beginning and as it is nearing a standard course, in a few years it should convince even conservative people exactly where it belongs in the curriculum.

MISTAKEN NOTIONS OF SCIENTIFIC PHENOMENA AS THEY NOW EXIST AMONG AVERAGE CITIZENS.

CLARENCE BONNELL

Harrisburg Township High School, Harrisburg, Ill.

This is the result of an investigation whose purpose was to learn something as to the prevelance of false ideas concerning common, everyday phenomena. It was believed that high school students, especially freshmen, would reflect the beliefs held in their homes and among their grown-up associates. It may be assumed that the more modern training of these students, coming from the upper stratum of society, as a rule, has made them more intelligent than the average citizen, concerning such phenomena as are here discussed, so that the result of the inquiry does not exaggerate the condition.

Ten statements were sent to fifty high schools in northern and southern Illinois, southern Indiana, and western Kentucky and Tennessee with the request that they be read to students without previous discussion or warning. It was suggested that students indicate by a show of hands whether they considered the statements true or untrue. The list was not sent to schools in Chicago or other very large cities because the topics dealt with matters some of which are not heard of by children of the large cities.

Returns were received from thirty-five groups of students numbering in all fifteen hundred eighty-one children representing

twenty-nine schools. A few schools made records from second, third or fourth year students instead of, or in addition to, freshmen which reduced the relative number of affirmative answers. All answers are tabulated below:

Statement to be Considered.	No. believing it true	No. in doubt	Percent believing it true
1. There is a reptile called a hoop snake which takes its tail in its mouth and rolls like a hoop.	653	243	41.3
2. The growth of vegetables is influenced by the "time of the moon" when the seeds are planted.	377	193	23.2
3. A man has one more rib than a woman since one of Adam's ribs was removed in creating Eve.	130	250	8.2
4. Hydrophobia may be prevented in one who has been bitten by a mad dog by applying a "mad stone" to the wound.	294	234	18.5
5. The heart beat is caused by the striking of the heart against the chest wall as it swings from side to side after the fashion of the clapper of a ball.	24	119	1.5
6. Warts may be removed by means of charms by some people: that is, some people have the power of causing warts to disappear by performing certain acts or saying certain things over them.	426	137	26.9
7. Malaria may be acquired by drinking water from wells, cisterns or reservoirs that have been contaminated with malaria.	940	199	59.4
8. When a mouse becomes fully grown, it is no longer called a mouse but is called a rat.	94	185	5.9
9. Wheat turns to cheat, that is, a farmer may sow wheat seed that is free from other seeds, and cheat will grow from some of the wheat seeds and appear at the harvest time.	207	417	13.0
10. A horse hair left in a watering trough may develop into a slender worm like animal called a "horse hair snake."	355	170	22.4

Thus it is seen that students answered that the statements were true, in numbers ranging from one and one-half per cent in one case to nearly sixty per cent in another. In addition, it must be remembered that an average of thirteen and a half per cent of them did not know whether the statements were true or untrue.

Replies were from these schools in Illinois: Harrisburg, Cairo, Thebes, Fairfield, Enfield, Bridgeport, Opdyke, Centralia, Tamaroa, Zeigler, Murphysboro, Cornell, Galena, Oregon, Rochelle, Belvidere, and two from near Chicago that requested that the exact locality be suppressed. Also, Sullivan, Corydon, Booneville, Princeton, Mt. Vernon, and Spencer, Indiana; Paducah and Franklin, Kentucky; and Shelbyville and Union City, Tennessee, sent replies.

Locality seemed to have little to do with the kind of replies given, The seven northern Illinois schools were stronger in the belief in the moon's influence on vegetable growth, the clapper-like beat of the heart, the mouse becoming a rat, and that wheat turns to cheat. The difference was slight on the questions of a woman's extra rib, charming away warts, and the existence of the horse hair snake. The south believed more strongly in the hoop snake and the mad stone and ran a little ahead of the more northern cities in the belief that malaria is caused from drinking water.

The conclusion is that there is yet much patient teaching of common-place biology to be done. When fifty-nine per cent of high school freshmen including some from higher classes do not know that the mosquito is the only transmitter of malaria and when hydrophobia is thought by eighteen per cent of them to be prevented by the so-called mad stone, it is a sad commentary on the teaching of biological subjects. Maybe I should say that it emphasizes the want of teaching.

A DEVICE FOR TEACHERS OF TRIGONOMETRY.

It is a common experience to find pupils who have difficulty in going over from the functions of an acute angle to the functions of a general angle. Indeed to avoid this difficulty many good texts and teachers handle the general angle from the beginning of the course. The homemade device shown in the figure is offered in the hope that it may assist some pupils over the hard place. No matter where the moving parts are held, they form a right triangle which is in correct position for yielding the functions of some angle. If the parts which are cross-hatched in the figure are painted red, the facts which we usually teach as a "law of signs" and which some of us remember by use of the

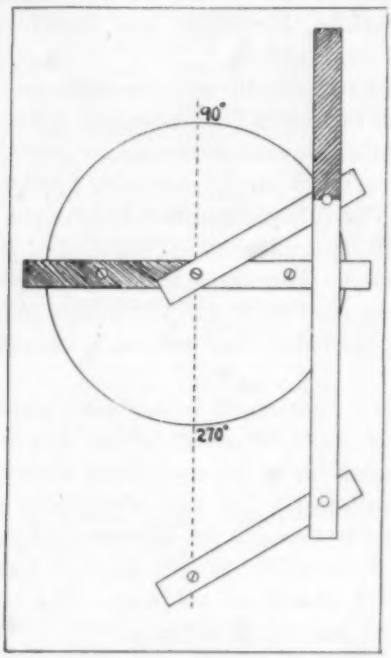
SA

mnemonic TC will become fixed in the memory. A clamp to hold the moving parts in any desired position and a set of

scales, graduated in tenths or hundredths of the radius and pasted on, are useful additions which would probably suggest themselves to any ambitious craftsman.

Some queries:

(1) Would there be any advantage in having each pupil make one for himself?



(2) How would he graduate the circle?

(3) Is this or some similar mechanism offered by the supply houses to assist physics teachers in treating simple harmonic motion?

NORMAN ANNING,

University of Michigan.

More teachers will be needed in the high and normal schools of the Philippines in the spring of 1925, according to a recent announcement made by the Bureau of Insular Affairs, War Department, Washington. Porto Rico needs teachers immediately for upper grammar grades and high schools.

A new college for women is to be established at Bennington, Vt. In its organization an attempt will be made to economize time and expenses of students. By eliminating long vacations both at Christmas and during the summer the founders hope to help students in three years to meet all the requirements for a regular college degree.

SURGEON CUTS WITH ELECTRIC NEEDLE.

Delicate electric needles, that part the tissues before they actually touch them, and render surgery less painful and dangerous, are to replace in large measure the gleaming array of scalpels and other sharp instruments that have always been thought of as the badges of the surgeon's profession. This is the prophecy of Dr. Howard A. Kelly, one of the leading surgeons of Baltimore and for many years prominent in Johns Hopkins medical circles.

Dr. Kelly has developed his instruments and technique to the point where in his own practice he has already relegated the scalpel to a secondary place, using the needles for almost all of his more important work. Among the advantages he claims for the new method are that it causes less pain and less bleeding, necessitates less handling of the body tissues with the fingers, and is followed by more rapid healing. The path of the needle through the flesh is self-sterilized, he states, so that there is less danger of operative infection.

Dr. Kelly cautions, however, against over-confident use of the new method by inexperienced persons. "These methods are not to be learned completely in a week or a year," he says. "They call for careful attention to a new technique, for discriminating judgment in their application, and for increasing boldness with a growing experience. The concept is a new one."

A Natural Explanation.

We all know that brothers and sisters look a good deal alike; also that cousins, aunts and uncles resemble each other. Usually, the nearer the kinship the closer the resemblance. The idea thus has become second nature in our thinking, that relatives are alike, and conversely that people who are alike must be relatives. There are any number of old proverbs that spring from this idea: "Like father, like son"; "What is bred in the bone will come out in the flesh".

Having seen this much about ourselves, it is easy to reason that other living things that look alike must also be related to each other. Even before the idea of evolution in its present form took hold, people spoke of lions, tigers, and leopards as belonging to the "cat family", and of wheat, oats and barely as members of the "grass family". The great naturalist Linnaeus, though he did not believe in evolution, put men and monkeys together into such a "family". Indeed, these family resemblances are so numerous throughout the living world that it is easier to think them due to a real kinship by common descent, a genuine "blood relationship", than to believe that they came about in any other way.

There is evidence that from the earliest times men must have had some sort of notion of a common bond of kinship among living things. The ancient Egyptians believed that the gods, who were frequently related to men, took up their abode in the bodies of animals. The modern Hindus believe that the souls of men sometimes go into the bodies of animals after death. Savage races in all parts of the world believe that their ancestor-gods were turtles, bears, eagles, and all kinds of animals, and sometimes even plants. Such primitive beliefs as this hint strongly at an original basic idea of the one-ness of all life.

When men began to do deliberate and connected thinking, and work out philosophical systems for themselves, this almost instinctive idea of the kinship and unity of living things could not help expressing itself.

The idea that the world and everything in it was not made by the Almighty in six days of twenty-four hours each, and that man and the

animals and plants were made by some process of gradual unfolding rather than by being moulded out of clay by hand is far older than Darwin. Some of the philosophers of Egypt and Greece and the other ancient lands had ideas about a creation in which a divine power made the earth, planted in it "the seeds of life", and left things to develop according to natural laws.

These ideas were passed on by the Greeks to the early Christians. Saint Augustine, for example, believed in such a process of gradual creation, and not in the six-day, "direct-action" method of making the world, as his writings clearly show. And the great thinkers of the middle ages, particularly St. Thomas Aquinas, found these ideas acceptable also. It was only after the coming of the Reformation that churchmen began to insist on the absolute acceptance of the very letter of the Bible story of the creation. So that really the idea of a six-day creation, now used as a fundamentalist test of right thinking, is not so old in theology as the idea of a creation by evolution.

The modern type of evolution, that is, the development of new species out of old, was thought of by a number of scientists and philosophers during the century before Darwin advanced his famous theory. Among them were the Frenchman Lamarck, the great German poet Goethe (who was an anatomist as well as a poet), and Darwin's own grandfather, Erasmus Darwin, who wrote his theory out in verse, so that nobody took it seriously.

The evolutionary idea was applied to other things than animals and plants before Darwin's time also. In fact, at about the beginning of the nineteenth century the air seemed to be charged with hypotheses of gradual developments instead of sudden creations. For contemporaneous with the early evolutionists was the great geologist Lyell, who taught that the rocks had been formed slowly, through long ages of cooling of an originally molten earth, through the slow deposition of silt and sand by rivers and seas, and through similar processes requiring unimaginable eons of time instead of mere brief days. Somewhat earlier was the astronomer Laplace, who taught that the sun and all the other stars, together with all their planetary systems, had formed through the infinitely slow condensation of the cloudy masses of star-gas or star-dust known as nebulae. Though modified in some important details, the main principles of the evolution of whole universes laid down by these two men are still accepted by scientists. Strangely enough, there has been little or no religious controversy over their theories—possibly because they were not obliged to deal directly with that very important insect, Man.

Thus we see that the idea of evolution itself had a natural origin and went through a process of evolution, and that it was not a "special creation", either by Darwin or any other scientist.

UNITED STATES NAVY A GREAT TRADE SCHOOL.

Gone are the days of the "jack of all trades and master of none," of "wooden ships and iron men." The United States Navy of to-day is made up of a corps of trained specialists in both the commissioned and enlisted personnel. Thousands of dollars are spent annually in training these specialists. Fundamentals of the 22 trades taught in the Navy are the same as corresponding trades in civil life. If the man trained in one of the 36 schools conducted by the Navy decides to reenlist at the expiration of his enlistment, he finds advancement waiting for him as he qualifies for more important work in his trade. If he does not reenlist, he has learned the fundamentals of his trade and can readily adapt himself to the specialties of civil life.—*School Life.*

CONSIDER FITNESS FOR COLLEGE IN HIGH SCHOOL.

Lack of adequate preparation before entering college and the incomplete and unsatisfactory character of records from secondary schools that students present for entrance are given by Dr. Ben D. Wood, assistant professor of educational research in Columbia University, as principal causes for the failure of 35 per cent of those admitted to college to achieve their goal.

Doctor Wood states in *School Life*, a publication of the Interior Department, Bureau of Education, that these conditions make necessary the giving of entrance examinations or intelligence tests. A new type standard test is now a regular part of the examination machinery in more than a dozen departments of Columbia College and in several of the professional schools of Columbia University.

REPORT OF THE SECOND ANNUAL CHEMISTRY WEEK AT RHODE ISLAND STATE COLLEGE, KINGSTON.

By Joseph W. Ince
Kingston, R. I.

The Second Annual Chemistry Week was held at Rhode Island State College from May 4th to 9th, 1925. The general purpose of the week as a whole was to interest as many people as possible in the science of chemistry and its applications to our daily life. The number of persons to be interested was, of course, confined to those directly concerned with the welfare of the college, namely the present student body and alumni and the general public of Rhode Island. It is difficult to measure how successfully the accomplishment of this purpose was realized but the following brief description of the various activities of the week will indicate to what a varied extent those responsible for the plans went in their efforts.

A popular industrial and educational exhibit was held throughout the whole period. In addition to the displays sent in by manufacturers, the instructors and students in the department arranged quite a series of exhibits, the students participating in a contest for prizes offered by a number of manufacturers and dealers in materials of chemical interest. On the last day of the exhibit, because of the greater attendance at that time, a few industrial firms staged demonstrations. There was, for example, the water gas generator demonstrated by the Providence Gas Co., an exhibition of glass blowing by Mr. Bicknell of Macalaster Bicknell, Cambridge, and explanations of scientific apparatus by a representative of George L. Claflin Co., Providence.

As a means of interesting the general student body, the chemistry department of the college had secured the services of Harrison E. Howe, editor of the Journal of Industrial and Engineering Chemistry, who addressed the weekly assembly on the subject of "Chemistry in the Nation's Business." Those who have heard Mr. Howe will know that it is unnecessary to state in this connection what a splendid talk he gave and how much inspiration he brought to the chemistry staff and to those students more especially interested in chemistry.

On the following day Frank W. Keaney, instructor in the department, gave a popular lecture on "Liquid Air" before the student body and local residents and this ever fascinating subject, illustrated by simple experiments, proved one of the most successful features in connection with the week as a whole. On another evening, the students' Chemical Society held a banquet, with some faculty members as their guests, and had invited the chemistry alumni of the college to return to renew old acquaint-

ances and to view the exhibit. The cooperation of the chemistry alumni of the college had been previously secured by having them contribute towards a trophy, which was offered to the high school winning the annual chemistry contest. And moreover, several of the alumni had taken an active part in securing and arranging displays for the exhibit and for the museum of the department.

On Friday the Rhode Island Section of the American Chemical Society held its May meeting at the college, with about twenty of its members from the vicinity of Providence motoring to Kingston. After visiting the exhibit and dining at the college, the members listened to a lecture on "Optical Glass" by J. C. Hostetter, manager of the Central Falls plant of the Corning Glass Works. Because of Mr. Hostett r's unique experience in this subject and the many samples he had to illustrate his talk, this also proved to be a valuable feature of the week.

On Saturday was held the second annual chemistry contest for the high school students of Rhode Island, arranged for this time because of the large number of high school people at the college in connection with the Interscholastic Track Meet, an annual affair. Twelve schools entered 57 students in the contest and several series of prizes were offered to individuals and to teams representing the various schools. As a major prize, the Chemistry Alumni Trophy attracted the most interest, being a silver plated metal wash bottle on an ebony standard, and having to be won three years in succession by a school to be retained permanently by that school. This year the team from Pawtucket High School wrested possession of the trophy away from Rogers High School of Newport. And in so doing, the team incidentally won for the library of the school a number of chemistry books and for their teacher, year's subscriptions to a number of chemical journals. Second place was won by Rogers High School of Newport and third place by Technical High School of Providence, each school being entitled to a number of chemistry books and the chemistry teacher to a number of subscriptions to journals. The members of the winning team first place and the three highest scoring individuals also received books as prizes. All of these prizes were awarded at the same time as the awards for the track meet were announced and there seemed to be fully as much rivalry and excitement in the contest of brains as of brawn.

Copies of the examination used in this year's contest, as well as that of last year will be mailed to any person requesting same. And detailed information in regard to methods used in making ready the exhibit or carrying out the plans of this Chemistry Week will be gladly furnished by the head of the chemistry department of the college, Joseph W. Ince.

Eleven States have enacted teacher tenure laws. These laws generally prescribe a period of probation for teachers before permanent appointment and guarantee security in their position during good behavior and efficiency.

Closing business establishments in order that all in the community may attend the graduating exercises is the unusual custom by which Pasadena (Calif.) honors its high-school graduates. More than 25,000 persons saw the pageant, following which the members of the class of 1923 received their diplomas in the great "rose bowl."

IMPORTANT NOTICE FOR MATHEMATICS TEACHERS.

Professor Raleigh Schorling, Ann Arbor, Michigan, Chairman of the Mathematics section of the Central Association of Science and Mathematics Teachers, is seeking material for the Thanksgiving program. Anyone who knows of material suitable for this program should communicate with him at once. Reports of investigations are preferred.

J. M. KINNEY.

JOHN M. COULTER.

Dr. John M. Coulter, Head of the Department of Botany of the University of Chicago, since the organization of the Department, formerly President of Lake Forest University and preceding that President of Indiana University, eminent botanist, teacher, student, author, editor and counselor in numerous scientific committees and societies, is discontinuing active headship of the Department of Botany at the University of Chicago at the close of this academic year.

During the present year Dr. Coulter has been assembling materials for a proposed volume upon "American Men of Science." This volume is designed for collateral reading by science students in secondary schools and elsewhere. It is being developed in connection with the program of work of the Lincoln School of Teachers College of whose staff Dr. Coulter will be a member during 1925-1926.

During the next year, Dr. Coulter will reside in Yonkers, and in addition to the above work in the Lincoln School, he will act also as general adviser in the work of the Boyce Thompson Institute for Plant Research.

SOUTHERN CALIFORNIA SCIENCE AND MATHEMATICS ASSOCIATION.

The May meeting of this association was held in the Polytechnic High School, Long Beach, California, May 9. The meeting was extremely interesting from beginning to end.

The address by William S. Kew of the Standard Oil Company was extremely helpful, as was the address by Captain Barager of the Coast Artillery United States National Guard. These two addresses occupied all of the morning session. An adjournment was taken for luncheon. This luncheon was extremely fine. At the dinner tables several speeches by different members were made. They were interesting in the extreme.

In the afternoon a field trip to San Pedro Hills and Fort McArthur was taken under the direction of Mr. Kew and Captain Barager.

This meeting proved to be extremely helpful and interesting to all who were in attendance.

C. H. S.

"OLD IRONSIDES" CAMPAIGN.

Lieutenant John A. Lord, U. S. N., the Naval Constructor who has been assigned the task of rebuilding the U. S. S. CONSTITUTION the famous fighting frigate, after a careful survey has reported to Rear Admiral L. R. deSteiguer, Commandant of the First Naval District, that any attempt to dock the historic ship in her present condition might result in her collapse and make her restoration impossible.

Most of the job of rebuilding "Old Ironsides" must be done while she is afloat, for the moment that she rests on her keel and on bilge blocks in drydock the vertical pressure on the center lines of the badly decayed frigate will cause her decks to buckle, and in all probability fall to pieces. This was the fate of the old wooden frigate "RICHMOND" some years ago when she was placed in drydock at the Norfolk Navy Yard. Her decks

buckled and her lines became so distorted that the Navy Department was forced to condemn her.

While Old Ironsides is afloat the pressure is evenly distributed, and the work of rebuilding above the water line will proceed without mishap. Then, with an elaborate system of shoring, she can be placed in a dry-dock to have her hull rebuilt.

Lieutenant Lord comes of a long line of Maine wooden-ship builders and is the only expert that the Navy Department could muster to rebuild the CONSTITUTION when the school children of the Nation raise $500,000, the amount necessary for her restoration. The Benevolent and Protective Order of Elks, upon the invitation of the Secretary of the Navy, have made plans to make contact with every school in the Nation and collect the children's pennies, dimes and nickels during the week of October 19th-24th.

THE LOCAL STUDY OF GEOGRAPHY.

By Ella B. Knight
Omaha, Nebraska.

Geography is one of the most vital and interesting subjects of our school curriculum. If we help our children to see how far environment has molded the living conditions and the occupations of our locality, we give them a key by which they may, to certain extent, interpret life in all parts of the earth. If we study local history we find that geographic factors have played an important part in the location and growth of our and neighboring communities. River valleys have proved the easiest routes of travel from older settlements to new and fertile lands; favorable ferry landings or forts have indicated advantageous sites for towns and cities; a waterfall has provided power for a mill which has drawn the needy labor to itself and formed the nucleus of a future manufacturing city.

Climate also has had a decided influence, in the history of farm practices and of crops used. If the early settlers in our subhumid and arid grasslands had adopted the agricultural methods which had proved successful in other dry regions of the earth, they would have escaped much of the hardships and financial loss which early Kansas, Nebraska, and Dakota farmers suffered.

A study of local geography, therefore, furnishes excellent material for developing geographic principles, or for making practical application of principles already developed.

There is nothing tedious or uninteresting for either teacher or pupils in this kind of study, and pupils have often quite as much information to contribute as the teacher has. In the rural community every farm boy and girl has learned many things about the use of the land, through practical family experience. The number of animals on the farm, the location of pastures and wood lots, the amount of land devoted to crops and the distribution of crops—all these are matters of early interest to farm children who are often surprisingly intelligent about utilization of the land. Experienced farmers who win a comfortable living from the land, have a fund of information more valuable than any text. They have learned, through their own experience aided by the experience of others, to what uses their land is best adapted on account of climate, soil, and topography, and we shall do well to avail ourselves of their instruction whenever we have opportunity.

The urban center has industries which differ widely from the rural industries, although the city is dependent upon the farm for its existence. No urban study can be made complete without an understanding of the

soil, the produce, and the transportation facilities of the territory for which the city is the logical market or manufacturing center.

No teacher need hesitate to undertake the local study on account of her own lack of training, for in every live community there are promoters who are anxious to advertise local industries and the advantages of the town or city for further growth. Promoters, as the term is here used, are not those professionals excess of enthusiasm leads investors to failure, but rather successful business men of the community who have contributed their experience to its real growth.

There are sound bases for all growth, and in the commercial and industrial development of a community these bases are often strongly geographic,—dependent on physiography, climate and natural resources.

Almost as soon as we begin our inquiries regarding the uses of farm lands, the sources of raw materials of industry or the distribution of manufactures, we see that there are fundamental reasons for the success or failure of certain activities within the region. Routes of transportation become of great significance, not only to the city dweller but to the farmer as well, for the intelligent observer travelling away from the railroad may see a difference increases.

Where it is possible, the local study may well have its own place as a unit in the curriculum, using the state or some other more unified area, as the region contributing the essentials of community growth. But where time is not available for local geography as a distinct study, the community should be studied as an important factor in the general study of the region to which it belongs.

The excursion has long since demonstrated its educational value, and in some foreign countries it is an essential part of the geography course of study. American tourists in Switzerland have seen an elementary school group of perhaps twenty children in charge of one or two teachers, carrying their camping outfits and out for several days on a geography field trip. It is not possible for us to conduct similar field trips, perhaps, but we can gain much knowledge from shorter excursions, studying the contour of the land, the effect on human life, or visiting the markets and factories of our cities and the farms and markets of our rural communities.

Whether or not our local study of geography is an organized unit, let us know our own community. Let us study the geographic influences which have favored or retarded its growth; let us study the site itself for its advantage or disadvantages of topography. Let us learn from what far distances we draw our supplies and where is the outer rim of our service in contribution to the world's needs. This study will richly repay us. It may become a hobby and recreation. It is study in which the final word is never written, and it will give us, if we do not already have it, a new and ever increasing interest in the whole field of geography.

EXTINCT VOLCANO ON ALASKA PENINSULA.

Remarkable Crater Recently Discovered.

Aniakchak Crater, on Alaska Peninsula is one of the most remarkable natural objects on this continent. It is an enormous basin, whose floor measures 6¾ by 5¾ miles, an area more than half as large as the District of Columbia. The rock walls that form the rim of the crater rise in places 3,000 feet above its floor, and a cinder cone in the crater rises to a height of 2,200 feet, four times that of the Washington Monument. In a hollow in the crater's floor lies a lake that is 2½ miles long and that has an area of 2 square miles.

A further measure of the magnitude of the crater may be had by comparing it with better-known volcanic craters, such as Kilauea, in the

Hawaiian Islands, which has a diameter slightly less than 3 miles, or the pit occupied by Crater Lake, in Oregon, which has a diameter of about 5½ miles, both being smaller than Aniakchak. Estimates of the amount of material that has been ejected from the present crater vary greatly, but the smallest quantity indicated by the available facts is about 8 cubic miles, and the actual quantity may have been more than 16 cubic miles.

There is no record that this volcano has been in eruption within historic time; in fact, the channels cut by the streams that flow down its slopes and the growth of vegetation on the ash from the crater indicate that Aniakchak Crater is one of the oldest in the whole series of volcanoes along the Aleutian Range. Indeed, the lower part of the cone in which the crater is situated may possibly have been formed before the last great period of glaciation, for some of the valleys that score its sides appear broad, as if they had been once occupied by ice and were later partly filled by volcanic ash.

The Aniakchak district, whose broad prairie-like valleys are rimmed by majestic sharp-peaked mountains, is impressive and in many respects unique. The former scene of terrific earth convulsions is now almost oppressively quiet, and the somber landscape, overswept by fitfully driven clouds, presents an aspect that is most weird.

Aniakchak Crater was discovered in August, 1922, by a party from the Department of the Interior in charge of R. H. Sargent, of the Geological Survey, while they were searching for possible petroleum-bearing areas in the Alaska Peninsula. A report by W. R. Smith, the geologist of this party, which has recently been issued as Professional Paper 132-J of the Geological Survey, gives a detailed description and views of the crater and its surroundings.

THE MILBANK MEMORIAL FUND.

People are now-a-days awaking to the fact that much more must be done toward preserving the health of the school children of the United States than has ever been done before.

The Milbank Memorial Fund is doing more than its share toward promoting the healthfulness of school children. The recent bulletin of this fund for July goes into some detail as to how the work is being done in Syracuse and Cattaraugus County, New York.

Statistics show that everywhere this fund has been in operation in its health demonstrations, the health of the pupils has been greatly enhanced. The best of success to the successful operations that this fund is putting forth.

MISSING CHEMICAL ELEMENT LOCATED BY ONE FAINT CLEW.

Element 61, one of the five missing chemical building blocks of all matter, may soon be revealed to the world.

Porf. C. J. Lapp of the University of Iowa told the American Physical Society meeting at Ann Harbor, Michigan, of his systematic search for this elusive element, which, though not heretofore detected by chemical or physical means, has had many of its properties predicted. Element 61 is known to be a rare earth, in the same class with cerium, whose oxides are used in the manufacture of gas mantles. There is a vacant space in the periodic table of chemical elements between number 60, neodymium, and 62, samarium, waiting to be filled.

One faint clew to missing element 61 has been found by Prof. Lapp

By examining some samples of rare earths carefully prepared by his colleague, B. S. Hopkins, he has discovered a single and very faint line in the spectrum produced by X-rays reflected onto a photographic plate from the rare earth sample. This line is not claimed by any other chemical element and corresponds very closely in wave-length to a line predicted on theoretical considerations as belonging to element 61. On this evidence Prof. Lapp believes it likely that element 61 is present in his samples of rare earths in quantities of about 1 part in 2000 or less.

Even if later research results in the definite identification of element 61 and its chemical isolation, it is doubtful if it will be of any commercial value. Very few of the rare earths are utilized in everyday life and they are usually so mixed up one with the other that they are only occasionally separated with any degree of purity. The rare earths include such unfamiliar elements as: serium, praesodymium, neodymium, samarium, europium, gadolinium, terbium, dysproium, holimium, erbium, thulium, ytterbium, cassiopeium.

There are now only five missing chemical elements, including number 61. All the rest of the 92 elements, from the lightest, hydrogen, to the heaviest, uranium, have been discovered. Numbers 43, 75, 85, and 87 are among the missing.

Many of the chemical elements have been first discovered in the spectrum and then found and isolated by chemical means. Helium was discovered in the sun in 1868 by lines seen in the spectrum of sunlight and not until 1895 was it isolated by Sir William Ramsay. The latest conquest of physics and chemistry was the discovery of element 72 hafnium, by the Dutch physicist Coster and the Hungarian chemist Hevesy working in the laboratory of Prof. Niels Bohr in Copenhagen. Using first the X-ray spectroscope and then chemical methods, they discovered that hafnium frequently occurs in zirconium minerals and makes up about one two-hundred-thousandths of the earth's crust. It is more plentiful than the well known metal, Tungsten. The periodic table of elements, devised by the Russian chemist, Mendeleeff in 1869, arranged the elements in logical order and allowed prediction of some of those then missing. Moseley, the young British physicist who was killed early in the World War, was able by applying X-ray spectroscopic methods to arrange the known chemical elements in an orderly series according to their atmoric numbers. This classification is more enlightening than the Mendeleeff periodic table and has allowed more precise prediction of the properties of missing elements.—*Science Service.*

MAKING THE LABORATORY THE BASIS OF HIGH SCHOOL SCIENCE.

H. H. Radcliffe,

High School, Decatur, Ill.

I was interested during the early days of the World War in a magazine article concerning the boyhood of a Cleveland, Ohio, man, I have forgotten his name now, who worked his way to an enviable place, not only in that, but also in other communities. At sixteen, as I remember the story, he was left as the sole support of this mother. Work just at that time was hard to find but some of the friends of the family interested themselves in his situation and he was finally given a place as night watchman

in the local gas plant. It was described as a position of small pay and less work, but an opportunity to "keep the wolf from the door."

When he reported for work he was shown the machinery that he was to watch and informed that his predecessors used to sleep most of the night as there would be noise enough, if anything went wrong, to waken him in plenty of time to prevent any injury to the plant. But this boy preferred not to sleep. He wanted to know the how and why of what was before him. He concluded the best way to find out was to study the thing itself. This he proceeded to do. When the day-man came to waken him he found him not asleep but closely observing some of the appliances. This he continued to do each night.

When the young man had learned what he could first hand, he took part of the daytime allotted to sleep to see what he could find in the city library on his subject. By getting what he could first hand, then reading what others had written of their observations, he soon won promotion. As he was given greater responsibility he advanced in knowledge of the plant. It was not long till he saw places he could reduce the cost of production. Not only this, he found sale for by-products. In this way the plant was put on a firmer financial basis. It was not many years till he was in demand to put on their feet similar plants in other places.

He gave as his key-note—and this is the part that particularly interested me—"Learn first all you can from the objects themselves, then find what others have said about them; finally, with their viewpoint in mind, go back to the object for confirmation."

At the time I read this article I was teaching, among other science subjects, a class of freshmen in botany. I had been studying how I might get them interested in the local flora. I determined to have them examine such representatives of the different groups as they could find, but in my order of selection. The complaints on their part toward the end of the semester were not encouraging to me. But early in the next semester they were led to see the development and evolution of types by such questions as: After studying these two types, what do you find in the pteridophytes that you did not find in the bryophytes? As individuals of different types were studied in this way their interest grew rapidly and by the end of the year, almost to a person, they wanted more science.

When we were called upon to close shop on Mondays in order to save coal, I was asked to conduct a class of adults, who were

working on other days, on the gasoline engine. A local firm sent an engine to the room where the class was conducted. We examined that engine and many were the questions asked. Many expressed regret when the time came to close. I think I learned as much as any of them.

Three or four years ago among five or six classes in chemistry I made the manual (Smith's) the basis of the work. In the elections for the next semester the class which was to follow this method was filled to overflowing before the others were full.

It is interesting to notice in this connection, the attitude of the War Department during the World War. To illustrate: One of our boys returned from the Great Lakes Training Station after the Armistice was signed and asked for credit in electricity for work he had done there. He presented his notebook for credit. Upon questioning him in regard to work in connection therewith, I learned that they were given a thorough practical training in wireless, sending and receiving, and then sent east (this one to Harvard I believe) for the theoretical side. I have read that colleges generally objected to the order of procedure (the farther east the more so) but the War Department came back with, "We must have doers."

Last year, during one six-week period of our school, I gave laboratory work first, followed by text assignment and discussion, to one group: While to another group an assignment was first made in the text and the next day illustrative laboratory experiments worked out. During the next six-week period the order was reversed with each group. A summary of the grades of both sections convinced me that on the whole the Cleveland "Gas Dr." was right. There were a few individuals who resented the order of procedure and asked me to tell them what to look for before they began the work. It is interesting to me to note that only a few days ago one of the girls said to me she found the work on the auto engine so interesting and got so much out of it she was going to put on some old clothes some day when she did not care if she got her hands smeared, and take their engine all apart. She is a sister to the one who made so much objection the year before.

The following are my directions for the work on the automobile. The engine was supplied by a local dealer.

The Gasoline Engine.

(Remember that other classes will work with this before you return, accordingly the small parts must be put in a box and

labelled as they are removed. Put the bolts, screws, clamps, etc., that hold parts together, each in a box by itself and label clearly.)

Remove the head and the valve housing cover. Slowly turn the crankshaft till one piston is about one fourth of the way down. Notice the position of each connecting rod, each valve and of each cam on the camshaft. Determine which cylinder is firing. Make a diagram of a section through all the cylinders and crankshaft showing each part in its present relative position. Superimpose upon this (preferably with another color) a section through the center of the valves and camshaft. By means of arrows show the direction each movable part is about to take. Also state in what part of the cycle each cylinder is now.

Turn the crankshaft till you can see one piston is as far down as it will go. Compute the volume of the cylinder above the piston and add the volume of the head-cavity. Assuming that the gas enters the cylinder when the piston is down at a pressure of one atmosphere and that none of the gas escapes, what will be the pressure when the piston is forced up as far as it will go? State the law involved. The difference in the positions of the pistons just indicated is the length of the stroke.

After the engine has been running for a time, the temperature is said to be about 600° F. When it is exploded the temperature is suddenly raised to 3000° F.; what would be the pressure then? What law is involved? State it. After allowing for the pressure necessary to compress the gas in another cylinder, and 10 per cent of the remainder for friction loss, what would be the total force on the piston head? What would be the available horsepower if the engine were making 1500 R. P. M.?

The Carburetor Assembly.

Study carefully the parts of a carburetor. Notice where the gasoline enters, where the air enters, where the valve for control is, and where the mixture leaves the carburetor. When you have mastered the relations of these, carefully make a diagram to show the relative position of each and by means of arrows indicate the course of the air, of the gasoline and of the mixture. If there be a control for high speed, notice the mechanical device for such control. State all the physical principles involved in the carburetor.

I maintain that chemistry and physics are Nature Studies.

As I recall the life of this man and continue to study the minds of my pupils, I have been led to believe that a first hand study of the objects of nature, or of objects which illustrate the laws of nature, followed, not preceeded, by a discussion of these laws will be the most thought-provoking method of procedure in high school science. It seems to me, above all else we want our pupils to THINK.

BOOKS RECEIVED.

An Introduction to Economic Geography, Volume 1 by Wellington D. Jones and Derwhent S. Whittlesey, University of Chicago. Pages xxxvii+375, 366 pages and diagrams and half-tones. 16x23.50 cm. Cloth, 1925. Price $5.25. University of Chicago Press, Chicago.

The Book of Plants by Bertha M. Parker and Henry C. Cowels, University of Chicago. Pages vi+252. 14x19.50 cm. Paper, 1925. Price $0.88. Houghton, Mifflin & Company, Chicago.

How to Teach General Science by J. O. Frank, State Normal School, Oshkosh, Wisconsin. Pages viii+194. 14x20 cm.

College Chemistry by Lyman C. Newell, Boston University. Pages vi+645. 15x20½ cm. Cloth, 1925. D. C. Heath & Company, Boston.

High Lights of Geography, North America, by David S. Jordan and Katharine D. Cather. Pages xv+358. 14½x21 cm. Cloth, 1925. $1.44. World Book Company, Chicago, Illinois.

Vacation Activities and the School, by the Lincoln School. 64 pages. 13x20 cm. Paper, 1925. Lincoln School of Teachers College, New York City.

Objective Studies in Map Location, by Harold Rugg, and John Hockett, Lincoln School. Pages x+132. 13x20 cm. Paper, 1925. Lincoln School of Teachers College, New York City.

Description of the Science Laboratories of the Lincoln School of Teachers College, by Earl R. Glen, Charles W. Finley, and Otis W. Caldwell, Lincoln School. 39 pages. 13x20 cm. Paper, 1925. Lincoln School of Teachers College, New York City.

High School Chemistry, by Charles E. Dull, Barringer High School, Newark, New Jersey. Pages ix+577. 13x19 cm. Cloth, 1925. Henry Holt & Co., New York City.

Commerce and Industry, by J. Russell Smith, Columbia University. Pages x+769. 14x20 cm. Cloth, 1925. Henry Holt & Company, New York City.

Practical Problem Projects, by F. W. Rawcliffe, Cicero, Illinois. 112 pages. 19x25.50 cm. Paper, 1925. F. E. Compton & Company, 58 E. Washington St., Chicago.

Plain Geometry by Arthur Schultz, New York University and Frank S. Sevenok, Stevens' Institute Technology. Pages xiv+317. 13x19.50 cm. Cloth, 1925. The MacMillan Company, New York City.

Plain and Solid Geometry by Arthur Schultz, New York University, and Frank S. Sevenok, Stevens' Institute Technology. Pages xiv+480. 13x19.50 cm. Cloth, 1925. The MacMillan Company, New York City.

Electricity and Magnetism by R. G. Shackel, Cooper Company's School, London. Pages vi+250. 13.50x19 cm. Cloth, 1925. $1.20. Longmans Green & Company, New York City.

The Folkes-Goff Practice Tests in Arithmetic for Grades 7, 8 and 9, by John G. Folkes University of Wisconsin and Thomas T. Goff, Normal School, Whitewater, Wisconsin. 21x28 cm. Paper, 1925. The MacMillan Company, New York City.

Exercises in Rapid Calculation by Harlen E. Reed and S. W. Fox. 22.50x28 cm. Paper, 1925. MacMillan Company, New York City.

Cost Account Book 1 & 2 by Lennes and Merrill. 22x28 cm. Paper, 1925. The MacMillan Company, New York City.

Inventory Account Book by Lennes and Merrill. Pages 48. 22x28 cm. Paper, 1925. The MacMillan Company, New York City.

Financial Account Book by Lennes and Merrill. Pages 64. 22x28 cm. Paper, 1925. The MacMillan Company, New York City.

Junior High School Mathematics, Book I, by George Wentworth, David E. Smith, and Joseph C. Brown. Pages vii+666. Cloth, 1925. $0.92. Ginn & Company, Boston, New York.

An Introduction to Economic Geography, Volume 1 by Wellington D. Jones and Derwhent S. Whittlesey, University of Chicago. Pages xxxvii+375+366, pages and diagrams and half-tones. 16x23.50 cm. Cloth, 1925. Price $5.25. University of Chicago Press, Chicago.

The Book of Plants by Bertha M. Parker and Henry C. Cowels, University of Chicago. Pages vi+252. 14x19.50 cm. Paper, 1925. Price $0.88. Houghton, Mifflin & Company, Chicago.

Preparation and Use of New-Type Examinations by D. G. Paterson, University of Minnesota. Pages vi+87. 13.50x19.50 cm. Paper, 1925 $0.60. World Book Company, Yonkers, New York.

Plain and Spherical Trigonometry by Paul R. Palmer and Charles W. Leigh, Armour Institute, Technology. Pages xiv+221+136. 15.50x 23.50 cm. Cloth, 1925. $2.50. McGraw-Hill Book Company, New York City.

Physics for Technical Students in College and Universities by William B. Anderson, Oregon State College. Pages xxiii+827. 16x23.50 cm. Cloth, 1925. Price $4.00. McGraw-Hill Book Company, New York City.

DIVISION OF CHEMICAL EDUCATION.

AMERICAN CHEMICAL SOCIETY, LOS ANGELES, CALIFORNIA, AUGUST, 1925.

C. S. Adams—The Antioch Plan of Cooperative Education as it Affects Students in Chemistry.

(1) The purpose and mechanism of the Antioch Plan are briefly discussed.

(2) Required courses. One year of college chemistry is required of all Antioch students. This requirement has necessitated two courses in Freshman Chemistry.
   (a) Cultural chemistry
   (b) Technical chemistry.
   The character of and method of selection of students for these two courses are discussed.

(3) The character of the other regular courses offered, including Autonomous courses, is described.

(4) The experience of placing students in chemical jobs is taken up. Advantages and disadvantages from the point of view of students and employer are enumerated.

(5) The growing necessity for a liberal education for chemists and how Antioch is meeting this problem are both briefly discussed.

EINSTEIN OBSERVATORY BUILT NEAR POTSDAM.

The Einstein observatory, built with funds contributed by foreign adherents of the Einstein theory, has recently been completed near Potsdam, Germany. It contains a large telescope and other astronomical facilities for testing and studying the theory of relativity and the newer theories concerning light.

To overcome the school shortage in New York City, the board of education is now constructing 50 new buildings and additions. If these were built on adjoining blocks on Broadway, says William H. Gompert, architect of the board of education, the line of buildings would extend from the Battery to Twentieth Street, a distance of about 3 miles. Plans and specifications for 40 more buildings are in various stages of preparation, and if these were added to the 50 the line would reach to Fifty-eighth Street, about 2 more miles. A number of buildings will be built in the next two or three years, and if these were added they would reach to about One hundred and thirty-fifth Street, the whole line of buildings extending more than 8 miles.

THE PROBLEM DEPARTMENT.

We are very sorry to announce to our readers that Mr. Joseph A. Nyberg, of the Hyde Park High School, Chicago, has been obliged to resign from the editorship of Mathematics problems of this journal. He has been obliged to do this on account of too heavy a program.

We are very fortunate, however, in securing for this position Mr. C. N. Mills, who has recently been appointed as head of the Mathematics Department of the Normal University, Normal, Illinois, and under his management, the high standard of the Mathematics problems will be maintained.

We are asking in this connection that teachers interested in this character of the work will help stimulate the department by contributing from time to time problems which in their judgment will be fit for other teachers.

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University, Normal, Ill.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

SOLUTION OF PROBLEMS.

876. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Given $2s$, c, and h_c. Solve the triangle; that is, derive formulas for the unknown parts. (The construction of the triangle is discussed in problem 863.)

Solved by George Sergent, Guatemala, C. A.

In setting up this solution the Editor uses h for h_c.

From the given data two equations involving $(s-a)$ and $(s-b)$ are easily set up.

$$h=\frac{2}{c}\sqrt{s(s-a)(s-b)(s-c)}.$$

$$c=(s-a)+(s-b).$$

olving these equations,

$$a=s-\tfrac{1}{2}c\left[1+\sqrt{1-\frac{h^2}{s(s-c)}}\right],$$

$$b=s-\tfrac{1}{2}c\left[1-\sqrt{1-\frac{h^2}{s(s-c)}}\right],$$

To determine the angles A, B, and C, we know that

$$\tan\tfrac{1}{2}C=r/(s-c),$$

where r is the radius of the inscribed circle. But $2rs=ch$. Hence

$$\tan\tfrac{1}{2}C=ch/2s(s-c).$$

In a similar manner, after substituting the above values for $(s-a)$ and $(s-b)$,

$$\tan\tfrac{1}{2}A=ah/2s(s-a),$$
$$\tan\tfrac{1}{2}B=bh/2s(s-b).$$

An incomplete solution, involving conic section theory, was sent in by *Michael Goldberg.* The *Editor* suggests that other readers attempt this problem.

(Continued on page 758.)

Quarter-Centennial Meeting of the

Central Association of Science and Mathematics Teachers

November 26, 27, 28, 1925

At the University of Chicago

Fifty-Seventh Street and University Avenue, Chicago, Ill.

Arrangements have been made so that members of the Association may secure railroad rates of one and one-half fare for the round trip by buying tickets to Chicago for the International Stock Show which comes at the same time as our meeting.

Headquarters Hotel, The Del Prado, Fifty-ninth St., and Dorchester Ave. Other nearby hotels are the Gladstone, Sixty-second St. and Kenwood Ave., Windermere, 1642 East Fifty-sixth St. Low rates are available down town at the Y. M. C. A. Hotel and at the Y. W. C. A.

To reach the University take Illinois Central express trains at Michigan Ave. and Randolph St. or VanBuren St. to Fifty-seventh St., Jackson Park express trains on the Elevated to University Avenue and Sixty-third Street, or take No. 7 Bus on Michigan Avenue which passes the University on 60th Street.

Registration Headquarters, The Reynolds Club, S. W. Corner 57th St. and University Avenue.

Executive Committee Meeting, Thursday, Nov. 26, 7:30 p. m. at the Del Prado Hotel.

Friday, Nov. 27, General Session, 10:00 a. m. Leon Mandel Assembly Hall, 57th St. and University Ave.

Address of Welcome—Vice President James H. Tufts of the University of Chicago.

Light Waves and Light Quanta—Dr. A. H. Compton, University of Chicago.

The Sargasso Sea Expedition—Wm. Beebe of the American Museum of Natural History or some other member of the Expedition.

Members of the Association are invited to take seats in the gallery and remain to the University Chapel Service 12-12:30.

The University Commons at the end of the hallway from Mandel Hall is open to members for meals, cafeteria plan. The cafeteria in Ida Noyes Hall is also available to the ladies.

Exhibits are in Bartlett Gymnasium, Northwest corner 57th St. and University Ave.

Friday, 4 p. m. A personally conducted tour of the University buildings, also inspection of the several Science buildings, under guidance of some member of each department, for those who prefer to see one Science Department in detail rather than the University in General.

Friday, 5:30 p. m. Reception to Past Presidents, Reynolds Club, 57th St. and University Ave.

Friday 6:30 p. m. Dinner, Past Presidents as guests. University Commons. The after dinner speaker will be Dr. Gerald B. Smith of the University of Chicago. Subject: Are Science and Religion Incompatible.

Friday, 8:30 p. m. An illustrated lecture. The Little Theater, Reynolds Club. Rollo Chamberlain, Dept. of Geology—Mountain Climbing in the Rockies.

Section Meetings

Friday p. m., November 27

BIOLOGY SECTIONS. Fred. W. Werner Chairman, Room 14, Zoology Bldg.
Survey of Recent Progress made in Zoological Research. Dr. C. E. Thoraldson, Northwestern University.
Survey of Recent Progress made in Physiological Research. Dr. A. J. Carlson, Chairman, Dept. of Physiology, University of Chicago.

CHEMISTRY SECTION. Margery Stewart, Chairman, Kent Theater, Kent Chemical Laboratory.
Application of Absorption Spectra to the Solution of Problems of Inorganic Chemistry. Dr. H. I. Schlessinger, University of Chicago.
Artificial Silk, Miss Nierick of Sears Roebuck & Co.
Some New Processes of Baking, Dr. H. E. Barnard, American Institute of Baking.
Methods in the Teaching of Chemistry, Chas. J. Pieper, University of Chicago, The School of Education.

GENERAL SCIENCE. H. P. Harley, Chairman, Room 13, Botany Building.
Planning the General Science Recitation.
Dr. Paul I. Pierson, Chicago Normal College.
New Books and Articles in the Field.
Hanor A. Webb, George Peabody College for Teachers
Francis D. Curtis, University High School, University of Michigan.
New Apparatus for General Science.
Ira A. Davis, University High School, University of Wisconsin.
Hanor A. Webb, Peabody College for Teachers.
New Curriculum Units.
E. S. Osbourn, John Burroughs High School, St. Louis
W. F. Roecher, Boys' Technical High School, Milwaukee
Miss Anna P. Keller, Lake View High School, Chicago
E. B. Collette, Lake View High School, Chicago.
Research in the General Science Field.
Earl R. Glenn, Lincoln School of Teachers, College, New York City.
S. Ralph Powers, Teachers College, New York City.

GEOGRAPHY SECTION. Katherine Ulrich, Chairman, Room 2, Rosenwald Hall.
Georgaphic Aspects of the Wisconsin Dairy Industry.
Dr. Tremarta, University of Wisconsin
Other speakers will be announced later.
Schemes for Presenting Regional Geography, Dr. D. S. Whittlesey.
Report of Investigation of the Interests of Geography Teachers in the area covered by the C. A. of S. & M. T.

MATHEMATICS SECTION, Raleigh Schorling, Chairman.
The Little Theater, Third Floor of Reynolds Club.
Speakers will be announced later.

PHYSICS SECTION, Elmer E. Burns, Chairman.
Recent Developments in Acoustics, Professor C. W. Stewart, University of Iowa.
Recent Developments in Optics, Dr. Henry Gordon Gale, The University of Chicago.
Changing Methods in Physics Teaching, Mr. Frank E. Goodell, West High School, Des Moines, Iowa.
A New Type of Physics Laboratory and Class Room, Mr. Earl E. Glenn, Teachers College, Columbia University.

Saturday, 9:00 a. m. Business Session, Room 13, Botany Building.

Saturday 10.00 a. m. All-Science Section Meeting. Kent Theater, Kent Chemical laboratory.
Recent Work on the Ether-Drift, Dr. Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio. President of the American Physical Society, 40 minutes.
Survey of Recent Progress in Botanical Research. Dr. Merle Coulter, University of Chicago. 30 Minutes.
Demonstration of Electric Collisions. Dr. W. D. Harkins, University of Chicago, 30 Minutes.
The General Science Course. Chas. H. Lake, First Assistant Superintendent of Schools, Cleveland, Ohio. 30 Minutes.

Saturday 12:30 p. m. Meeting of the Executive Committee, private dining room, Quadrangle Club.

Saturday, 2:00 p. m. A conducted tour of the International Live Stock Show, Stock Yards.

Write Dr. Elliot R. Downing, President, University of Chicago or Ada L. Weckel, Secretary, Oak Park, (Ill.) High School, for further particulars.

Printed programs will be mailed to members about Nov. 1.

(Continued from page 755.)

877. *Proposed by R. T. McGregor, Elk Grove, Cal.*

Sum to infinity the series $2/3+4/5+6/7+8/9+\ldots\ldots$

Solved by L. Carlitz, Philadelphia, Pa.

In this series $u_n = 2n/(2n+1)$. The limiting value of u_n as n becomes infinite is unity. Hence the series is divergent, and its sum is infinity. The given series cannot be expressed as a function of n as it would imply the summation of the harmonic series

$$\Sigma 2s/(2s+1) = \Sigma 1 - \Sigma 1/(2s+1).$$

878. *Proposed by George Sergent, Guatemala, Central America.*

Prove that in any triangle $\tan\frac{1}{2}C = (a-b)/(r_a - r_b)$.

Solved by R. T. McGregor, Elk Grove, Cal.

$$\tan\tfrac{1}{2}C = Area/s(s-c).$$

Also, where r_a means the radius of escribed circle opposite side a,

$$r_a = Area/(s-a),$$

and $$r_b = Area/(s-b).$$

Subtracting, $$r_a - r_b = Area(a-b)/(s-a)(s-b).$$

Rearranging, and multiplying both terms of the right member by $s(s-c)$

$$\frac{a-b}{r_a - r_b} = \frac{s(s-a)(s-b)(s-c)}{(Area)s(s-c)}.$$

Substituting the above value for $\tan\frac{1}{2}C$,

$$\tan\tfrac{1}{2}C = (a-b)/(r_a - r_b).$$

Also solved by a similar method by *Michael Goldberg, Philadelphia, Pa.* An elegant solution involving properties of the nine-point circle was sent in by the *Proposer.* This solution will be published in a later issue. A good solution was sent in by *L. Carlitz, Philadelphia, Pa.*

879. *Proposed by C. E. Githens, Wheeling, W. Va.*

Given a circle and its center. By means of the compass alone, find the vertices of the inscribed pentagon.

I. *Solved by F. A. Cadwell, St. Paul, Minn.*

Let A be the center of the given circle. Take any point, as B, on the given circle as a center and with radius BA describe a circle intersecting the given circle in C and D. By the method used in the solution of *Problem 658* find the point E on circle A, which shall be the corner of a square of which A and B are also corners. With C and D as centers and radii equal to EB describe two circles intersecting in F. Take any point, as E, on circle A as a center and with a radius equal to EF describe an arc intersecting circle A in G; with G as a center and the same radius locate H; continuing in like manner locate points I and J. Then points E, G, H, I, and J are the vertices required.

II. *Solved by Michael Goldberg, Philadelphia, Pa.*

Two solutions, one involving the usual geometrical method is not given here. The solution given here is found in Adler's "Theorie der geometrical Konstruktionen."

With the radius of the given circle locate the vertices of a regular inscribed hexagon, A, B, C, D, E, and F. With radius AC and centers A and D draw arcs intersecting at G. Since $AC = \sqrt{3}r$, $GO = r\sqrt{2}$. With C and E as centers and with radius GO, draw arcs intersecting at H. If J is the midpoint of OD, $HJ = r\sqrt{5}/2$, and $HO = r(\sqrt{5}-1)/2$, which is the side of an inscribed decagon. Hence the vertices of the pentagon are easily located.

Also solved by *W. W. Horner, Redstone High School, Republic, Pa.; George Sergent, Guatemala, C. A.; L. Carlitz, Philadelphia, Pa.; Seymour Tucker, Junior Class, Redlands High School, Cal.;* and the *Proposer.*

880. *For High School Pupils. Proposed by L. E. Lunn, Heron Lake, Minn.*

If the interior and exterior angles at both A and B of $\triangle ABC$ be bisected, prove: The angle between the interior bisector of A and the exterior bisector of B equals the angle between the interior bisector of B and the exterior bisector of A.

Solved by Donald W. Smith, The Taft School, Watertown, Conn.

Given a triangle ABC; BP bisecting the interior angle at B; AQ bisecting the interior angle at A; BQ bisecting the exterior angle at B; AP bisecting the exterior angle at A. To prove that angle P equals angle Q.

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(Signed) Ralph P. Bliss, Chairman,
Department of Mathematics.

"I find in its wealth of material a constant source of inspiration in my teaching."
(Signed) Julia Simpson,
Faculty Advisor of Mathematics Club.

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Extend AB to X, and BA to Y. Angle ABC and angle CBX are supplementary. Angle PBC and angle CBQ are complements; also angle QAC and angle CAP. Therefore triangles QOB and POA are right angled. BP and AQ interesect at O. The angle BOQ equals the angle AOP. Hence angle P equals angle Q.

Also solved by *Andrew Pelzer, Dickinson H. S., Metuchen, N. J.; Grace Oosterheart, Chicago; Seymour Tucker, Redlands H. S., Cal.; Fred Howard, Hibbard High School, Chicago; William Begg, Taft H. S., Watertown, Conn.; Stockton Green, Taft H. S., Watertown, Conn.; Tillie Dantowitz, Kensington H. S., Philadelphia, Pa.; Richard Gregoire, St. Bede College, Peru, Ill.; Geometry class of Culver High School, Culver, Ind.; James Thorns, Watertown, Conn.*

PROBLEMS FOR SOLUTION.

891. *Proposed by Walter C. Eells, Whitman College, Walla Walla, Wash.*

(Suggested by Problem 873.) Prove that the cube of any integer when divided by 8 leaves the same remainder as does the integer itself when divided by 8, if the integer is odd, and leaves no remainder if the integer is even.

892. *Proposed by George Sergent, Guatemala, C. A.*

Given two adjacent supplementary angles, and the bisector of one of them, construct the bisector of the other, using the ruler alone.

893. *Proposed by A. S. Haynes, Bangatore, S. India.*

Inscribe the maximum rectangle in a given sector of a circle.

894. *Proposed by Royal V. Bryant, Lowell, Mass.*

Prove that the sum of any series of consecutive odd numbers beginning with unity is a perfect square.

895. *Proposed by the Editor.*

Show how to cut a cube so that the section is a regular hexagon.

SCIENCE QUESTION.

Conducted by Franklin T. Jones

The White Motor Company, Cleveland, Ohio.

To Readers of School Science and Mathematics:

You are invited to propose questions for solution or discussion.

You are asked to answer questions.

Examination papers are always desired. Send in your own papers or any others. Some are interested in college entrance examinations, others in school or college examinations. All are desired.

Please address all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E., Cleveland, Ohio.

PROBLEMS AND QUESTIONS FOR SOLUTIONS.

472. How could the baby do it!

Assume the first floor 15 feet high, the second and third floors 12 ft., and the window ledge 2 ft. above the floor in the third story, the woman who screamed 5½ ft. tall, and the man who caught Moe 6 ft. tall.

(a) How long after Moe started to drop did the woman begin to see him?

(b) What is a possible reaction time before she began to scream?

(c) How long before the sound of her voice reached the man?

(d) How long did it take him to put out his arms?

(e) How long did it take Moe to drop?

(f) How long did the man wait "with outstretched arms" until Moe dropped into them?

(g) Do you think the reporter guessed at the figures used or reasoned them out?

After all *we do live* in a *mathematical* world and even a baby's fall can be reduced to a mathematical and physical basis.

Figure it out and send in your results.

Newspaper Clipping, Aug. 10, 1925:

ASTRONOMY TEACHERS

NEW ESSCO CONSTELLATION CHARTS

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*Chart SC*1—**Equatorial Region**

Shows principal stars of every important constellation from 60° North to 60° South, together with Equator, Ecliptic and principal Hour Circles.

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Chart 42 inches x108 inches, cloth backed, and mounted on a spring roller.

*Chart SC*2—**NORTH CIRCUMPOLAR REGION**

Shows principal stars of every important constellation from 30° North to 90° North.

Chart 42 inches x54 inches, cloth backed, and mounted on a spring roller.

*Chart SC*3—**SOUTH CIRCUMPOLAR REGION**

Shows principal stars of every important constellation from 30° South to 90° South.

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Special Note: Small reproductions of these charts may be had for desk use by individual students.

For detailed information on above charts, send for Bulletin C501.

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PART B

Any 4 of these questions

1. Construct the Periodic Table of the elements showing type oxide and type hydride or halide. What are the disadvantages of this classification? How did Moseley overcome these difficulties?
2. Make a chart showing the compounds that can be made directly or indirectly from common salt, giving equations for each conversion, and naming your compounds.
3. Describe typical methods of metallurgy and illustrate each. Equations for all reactions.
4. Give all the methods for making compounds of the metals that you know. Illustrate each and explain the principle of the method clearly.
5. (a) Balance the following by valence change method, indicating the change in valence:

1. $HNO_3+HCl+Pt=H_2PtCl_6+NO+H_2O$
2. $HNO_3+Ru+H_2O=RuO_4+NO_2+H_2O$
3. $MnO_2+KOH+O_2=K_2MnO_4+H_2O$
4. $KMnO_4+FeSO_4+H_2SO_4=K_2SO_4+Fe_2(SO_4)_3+MnSO_4+H_2O$

(b) Give equations for the following reactions:

1. For the preparation of calcium cyanamide starting with limestone.
2. For the preparation of bismuth subnitrate from metallic Bi.
3. For the preparation of ortho-arsenic acid from elemental arsenic.
4. For the preparation of lithopone.
5. For the action of alum baking powder on water.

474. College Board Chemistry, 1925:

(a) Which is a better examination, the Western Reserve New Type examination or the College Board examination? (Please vote! A vote is wanted from every reader.)

(b) Are there any New Type questions on the Board list? Do you think there should be?

(c) Is this Board examination too complicated in method of giving choices of questions?

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CHEMISTRY

Saturday, June 20 9 a. m.–12 m.

Answer ten questions as indicated below.

Number and letter your answers to correspond to the questions selected.

No credit will be given for problems on this paper unless the methods of calculation are clearly indicated. Final numerical answers need not be carried beyond one place of decimals.

PART I

(*Answer all questions in Part I*)

1. Write equations for the following reactions using formulas throughout. Equations must be properly balanced to receive credit.
   a) Sodium hydrogen carbonate heated
   b) Silver sulphate and aluminum chloride
   c) Potassium nitrate and sulphuric acid
   d) Concentrated hydrochloric acid and manganese dioxide
   e) Copper and hot, concentrated sulphuric acid
2. Define or explain the following terms, illustrating each by one example:
   (*a*) basic oxide; (*b*) neutralization; (*c*) reducing agent; (*d*) catalyst; (*e*) distillation.
3. *a*) How many grams of potassium chloride are formed by heating 10 grams of potassium chlorate until no more oxygen is evolved?
   b) How many liters of dry hydrogen, measured at 760 mm. and 546°C., are produced by the action of 13 grams of zinc with dilute sulphuric acid?
   (Atomic weights: Zn 65, K 39, Cl 35.5, O 16, H 1. 22.4 liters of hydrogen at 760 mm. and 0°C. weigh 2 grams.)

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BABY TUMBLES THREE FLOORS TO MAN'S ARMS

Pedestrian Attracted by Woman's Screams, Saves Small Boy.

(Plain Dealer-N. Y. Times Wire)

NEW YORK, Aug. 10.—Little Moe Klein, 2, leaned out of the window of his home on the third floor of 978 Alder Street at noon today. Suddenly he lost his balance and fell out. A woman from the window above saw Moe drop and screamed. The scream came one-fiftieth of a second after Moe started his precipitous descent.

An unidentified man who was passing snapped his head back, reached out his arms and waited for Moe to reach him. He held this position for four-fifths of a second. Then Moe was safe in his arms. But he was yelling. That was all that was the matter with him.

The hero of this slow motion picture disappeared without leaving his card.

473. New Type Chemistry Examination—Western Reserve University, June, 1925.

(a) Do you favor the *New Type* questions as given in Part A? (Will each reader send in a vote *at once!* If you don't answer, the Editor will think you don't read.)

(b) How can a student *study* for such an examination? Is it desirable that he should?

(c) Should examinations be abolished? Why?

FINAL EXAMINATION—W. R. U.

CHEMISTRY 2.

PART A

Place a + in bracket if correct; a − if incorrect. Leave empty if not sure.

1. ( ) Metals are elements which form simple cations in water solution.
2. ( ) In metallurgy a slag is introduced to convert the ore to a liquid.
3. ( ) Chromium may be prepared by Goldschmidt's process.
4. ( ) The molecules of a slightly soluble substance have a definite concentration at all times in solution.
5. ( ) All sulfates are soluble in water.
6. ( ) Lithium resembles magnesium more than it does sodium.
7. ( ) Glauber's salt is another name for anhydrous sodium sulfate. (Na^2SO^4)
8. ( ) In making gunpowder sodium nitrate should be used as it is cheap and readily gives up its oxygen.
9. ( ) Calcium belongs to the alkali group of metals.
10. ( ) Lime is made by heating limestone in a current of air.
11. ( ) Mortar is a mixture of slaked lime, sand and horsehair.
12. ( ) Hard water is water in which it is hard to dissolve things.
13. ( ) The cyanamide process may be used in the fixation of nitrogen.
14. ( ) Barium nitrate colors the flame green.
15. ( ) Magnalium may also be called aluminum amalgam.
16. ( ) Boiler scale is formed when hard water evaporates in boilers.
17. ( ) Zinc hydroxide dissolves in excess NaOH because a soluble zincate forms.
18. ( ) Cadmium may be distinguished from all other metals because it forms a yellow sulfide.
19. ( ) An alum is chemically different from a spinel.
20. ( ) Wrought iron, steel and cast iron are chemically very similar.
21. ( ) Ferrous compounds resemble those of magnesium; Ferric, aluminum.
22. ( ) Spelter is the name given to impure copper.
23. ( ) Mercuric and silver chlorides behave alike toward ammonia.
24. ( ) Stannic chloride is a white crystalline solid soluble in water.
25. ( ) $MnSO_4$ is not the formula for epsom salts.

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4. Mention by name and formula the substances used in a laboratory preparation of each of the following: (*a*) carbon dioxide; (*b*) hydrogen sulphide; (*c*) sodium chloride; (*d*) copper from cupric sulphate; (*e*) ammonium hydroxide solution from an ammonium salt.
5. *a*) Name four important constituents of the atmosphere.
   b) Designate (1) one gas that is absorbed by plants; (2) one that is absorbed by animals; (3) one that is evolved by plants; (4) one that is evolved by animals in their life processes.
   c) What familiar tarnishing of a metal indicates the presence of some sulphur compound (probably H_2S) in the air of our homes?
   d) Is air a compound or a mixture? Give two reasons in support of your answer.
6. *a*) List the following elements in the order of their activity, placing the most active first: gold, zinc, sodium, copper, hydrogen.
   b) State which of the foregoing elements would not oxidize in air even at high temperature.
   c) State which would most readily react with moisture at room temperature.
   d) State the essentials of Dalton's atomic theory.
   e) Name two fundamental laws of chemistry that are explained by the atomic theory and state one of these laws.

PART II

(Answer four questions from Part II. Answers to extra questions will receive no credit.)

7. *a*) How would you treat a mixture of finely powdered sodium chloride, calcium carbonate, zinc, and charcoal so as to obtain the first and last substances pure and dry?
   b) How would you test to determine whether a gas is methane or hydrogen?
   c) Give the tests by which you would recognize sodium sulphate and a nitrate iron.
8. *a*) Show by equations the formation of zinc sulphate in five different ways.
   b) Describe the apparatus and method of procedure in the laboratory experiment for determining the percentage of water in crystallized barium chloride.
9. Indicate whether the following statements are true or false:
   a) All elements are solids or gases under normal conditions.
   b) An increase of temperature has the general effect of decreasing the speed of a chemical reaction.
   c) A solution is a homogeneous body whose composition may vary between certain limits.
   d) A water solution of salt and a water solution of sugar of the same molecular concentration have the same freezing point.
   e) Water has less energy than the elements into which it is decomposed.
10. If a mixture of acetylene (C_2H_2) and oxygen, in reacting proportions, is exploded, carbon dioxide and water vapor are produced. Will the total volume of the products be greater or less than that of the original gases if all are at 200°C. and 760 mm.? What are the relative volumes of the two products?
11. *a*) What is a saturated solution? How would you determine whether a solution is or is not saturated? Describe the procedure in making a "supersaturated" solution.
   b) What is the effect of temperature on the volume of gas that can be dissolved by a liquid? Give an example in illustration of this.
12. *a*) How many liters of ammonia could be formed by the complete reaction, under proper conditions, of 15 liters of hydrogen with an ample volume of nitrogen? All gases are measured under standard conditions of temperature and pressure.
   b) Ten liters of a certain gas weigh 11.6 grams at 0°C. and 760 mm. What is the molecular weight of the gas? Is it heavier or lighter than nitrogen? (Atomic weight N 14.)

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13. *a*) Explain why coal tar may be said to be a by-product of the steel industry. Mention three important chemical compounds that are obtained from coal tar.
    b) What is meant by the "fixation" of nitrogen? Explain why it is essential for the prosperity of a nation in peace, and for the prosecution of a war, to have such a process at command.
14. *a*) What raw materials are required for the manufacture of (1) soap, (2) common glass, (3) bleaching powder, (4) aluminum?
    b) Explain how electrolysis is used for the refining of metals and give an example.
15. Show by equations how you would treat the following minerals to prepare other substances of commercial importance: calcium phosphate, limestone, sodium nitrate, gypsum, manganese dioxide.

SOLUTIONS AND ANSWERS.

462. *Borrowed from the mathematicians.*

(Our excuse for publishing this as a *science* problem lies in the *motion* of bee and automobile.)

Two automobiles twenty (20) miles apart are approaching each other, each traveling ten (10) miles per hour. A bee which flies at the rate of fifteen (15) miles per hour starts at the radiator of one automobile and flies back and forth between their radiators until the autos meet.

How far does the bee fly?

(N. B.—This problem can be solved without any mathematics higher than arithmetic. Explain either way.)

Answer by George H. Gatze, 55 Hanson Place, Brooklyn, N. Y.

The autos will take one hour to meet. If the bee is flying all the time he will fly for one hour or 15 miles. Q. E. D.

Or by progression.

The time taken by the bee for first trip is 4/5 hours.

$$\text{Since } 15x+10x=20$$
$$x=4/5 \text{ hours}$$

The time for second trip is

$$15x+10x=4$$
$$x=4/25 \text{ hours}$$

or for successive trips,

$$4/5,\ 4/25,\ 4/125,\ 4/625 - - - - \text{ hours}$$

The sum must be one hour

These four terms add to 624/625

So add 1/625 hour to make one full hour.

The distance for each trip will be the sum of these, multiplied by 15

60/5, 60/25, 60/125, 60/625, 15/625 miles

Sum = 9375/625 miles or 15 miles.

The bee at the rate will be in mid air when the two cars meet, since we should add 4/3125 hours where we have added 1/625 hours, to allow the bee to land on the next radiator.

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PERSONALS.

Professor C. W. Stewart, head of the Physics Department, University of Iowa, gave the address at the dedication of Wakefield Science Hall at Park College, Parkville, Missouri.

Doctor Edward L. Thorndike, professor of educational psychology, Teachers' College, Columbia University, in consideration of his great work, has been awarded the Butler gold medal given every five years by the Columbia University for distinguished work in the theory of education.

Doctor A. C. Lunn, professor of applied mathematics and a man who knows what he is talking about, recently gave a series of interesting lectures before the Department of Physics at the University of Kentucky.

Professor Charles F. Palmer, who for the past year or so has been in connection with the research department of the institute of American meat packers, will join the staff of the University in September.

Doctor Vernon Kellogg of the National Research Council has been in Europe this summer attending the International Research Council at Brussels, also attending the International Intellectual Cooperation in Geneva, also he attended the British Association for the advancement of science as representative of the National Research Council of the American Association for the advancement of science.

Doctor B. M. Duggar of the Missouri Botanical Garden has been appointed chairman of the Division of Biology and Agriculture with the National Research Council.

Doctor Louis A. Bauer has been elected a membership to the Institute of Coimbra, Portugal. He represented the Department of Terrestrial Magnetism of the Carnegie Institution.

We are sorry to announce that Doctor Percy N. Evans, for many years at the head of the Chemistry Department of Purdue University, died on the 3rd of July.

We are pleased to announce that Doctor Clarence C. Little, who resigned from the presidency of the University of Maine, has been elected president of the University of Michigan.

NOTE ON REMOVING CARBON FROM TEST TUBES.

By Eaton V. Miller,
East Lansing, Mich.

Recently the tendency in teaching high school chemistry seems to incline toward the practical realm and we note that more and more of the modern text book is devoted to the application of general chemistry.

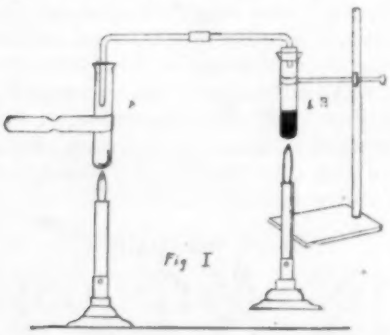
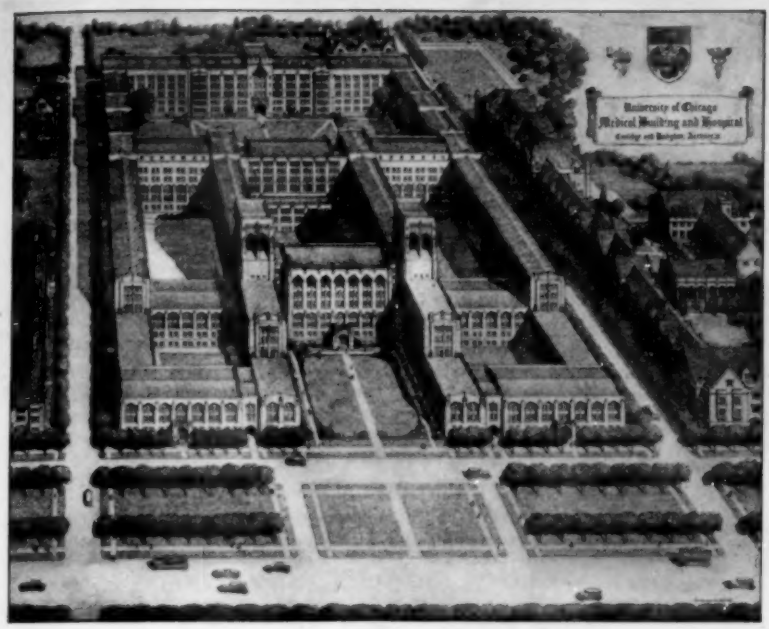


Fig I



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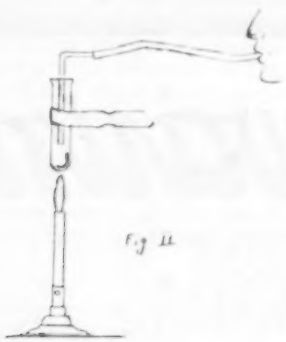
It is with this in mind that I offer the following suggestion to high school instructors to aid them in a practical application of one of the first experiments in chemistry as well as to enable the student to apply his own knowledge. It may be interesting to learn that the principle of the following method was suggested to me by one of my pupils.

During the first few weeks of the course nearly every instructor is confronted many times with the usual question: "How can I clean this test tube?" All are familiar with that almost immovable crust of carbon remaining in test tubes after starch, sugar, or other organic materials have been decomposed by heat. Many hard-glass test tubes are destroyed in the mad attempt to obtain immaculate glass-ware. The following method is suggested for the cleaning of these "carbonized" tubes.

$$C + O_2 = CO_2$$

As is indicated in Figure 1, the tube "A" contains the undesired carbon and is being heated in order to raise the temperature of the carbon to the combining temperature. Tube "B" contains potassium chlorate



and manganese dioxide and, when the experiment is conducted as indicated in the drawing, the carbon combines with the oxygen generated and is evolved as carbon dioxide. Nothing could be more simple, except—

METHOD NO. 2.

In the illustration in Figure II the blast of pure oxygen is replaced by the exhaled breath. In this second method the difficulty arising from the lower percentage of oxygen present in the blast may be surmounted by the increase in pressure which the operator may exert. One precaution is necessary. Tube "A" must be heated a while before the air is introduced in order that the moisture from the exhaled air may not condense on the tube and cause it to crack.

This method may be used in removing sulphur or any other substance which will combine with oxygen to form a gas. In all cases the tube entering tube "A" must be glass and must be far enough away from the operator so as not to cause him any discomfort. Also in instances where the gas formed is obnoxious the hood must be used.

This may suggest to the student the method used for removing carbon from the cylinders of internal combustion engines or of other uses. In any event it is training the student to apply his knowledge shortly after acquiring it.

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ARTICLES IN CURRENT PERIODICALS.

American Botanist, Joliet, Ill., for July, *$1.50 per year, 40 cents a copy.* "Plants of Wolf Lake Indiana-Illinois," Donald C. Peattie, "The Meanings of Plant Names XXIII Caprifoliaceae," Willard N. Clote, "Popular Handbooks of the United States," Flora, "Codes of Nonsenclature and Botanical Congress," Herbert C. Hanson.

American Journal of Botany, Brooklyn Botanic Garden, for June, *$6.00 per year, 75 cents a copy.* "Some of the Factors involved in the Sexual Reproduction of Marchantia Polymorpha," Frank B. Wann; "Studies on Aberrant Forms of Sphaerocarpos Donnellii," Alfred M. Wolfson; "The Embryogeny of Pastinaca Sativa," Floyd E. Beghtel; "The Geographical Distribution in North America of Poison Ivy (Rhus Toxicodendron), and Allies," James B. McNair; "A New Conjuga'e from Woods Hole," I. F. Lewis.

American Mathematical Monthly, Ann Arbor, Mich., for June-July, *$4.00 per year, 45 cents a copy.* "The Solution of Equations by the Method of Successive Approximations," L. R. Ford; "In the Surnamed Chosen Chest: I. Association Copies," D. E. Smith; "A Solution of the Quadratic Congruence Modulo p, $p=8n+1$, n odd," P. A. Caris; "The Continuity of a Function Defined by a Definite Integral," R. L. Jeffery; "Questions and Discussions: Question 53. Discussions—'Concerning Cubic Polynomials,'" Louis Weisner; "A Digit for Negative One," J. P. Ballantine; "On the Kinematic Construction of Certain Higher Plane Curves," R. E. Moritz; "Note on the four-leaf Rose," C. H. Chepmell.

Chemical Education, College Park, Md., for July, *$2.00 per year, 25 cents a copy.* "The Future of the Synthetic Organic Chemical Industry in America," Charles H. Herty; "Observations on Teaching the History of Chemistry," Edgar F. Smith; "Teaching Principles of Electrodeposition," W. Blum; "Correlation of Lecture, Recitation and Laboratory Work in General Chemistry," C. A. Brautlecht; "Application of the Electron Concept to Oxidation-Reduction Reactions in General Chemistry," Stuart R. Brinkley; "Objectives in Teaching Chemistry," H. R. Smith; "Chemistry and Science in Prehistoric America," James A. Branegan; "Educating the Public in the Use of the Metric System," Harvey A. Neville; "The New Assistant," "A Metric Play," Alton L. Hall and the General Science Class of Bishop, California; "Some Suggestions as to the Selection of a Laboratory Manual for High-School Chemistry," W. G. Bowers.

Condor, Berkeley, Calif., for May-June, *$3.00 per year.* Observations on the Xantus Hummingbird (with one photo)," Chester C. Lamb; "The Courtship of the Brandt Cormorant," Charles W. Townsend; "Some More Notes on Saskatchewan Birds (with one photo)," H. H. Mitchell; "Photographing the Rufous-crowned Sparrow (with four photos)," Roger Simpson; "Nesting of the Allen Hummingbird in Golden Gate Park (with four photos by *Ynes Mexia*)," Harold C. Bryant; "A Report on the Birds of Northwestern Alaska and Regions Adjacent to Bering Strait. Part III (with two photos)," Alfred M. Bailey.

Monthly Weather Review, Washington, D. C., for March, *$1.50 per year, 15 cents a copy.* "An Account and Analysis of the Meisinger Free-Balloon Flights (10 figs.)," V. E. Jakl; "On the Mean Variability in Random Series," E. W. Woolard; "Energy Distribution in the Visible Spectrum and Sunlight and Skylight (3 figs.)," H. H. Kimball; "Recent Oceanic Phenomena Along the Coast of South America," R. C. Murphy.

Photo-Era Magazine, Boston, Mass., for July, *$2.50 per year, 25 cents a copy.* "A Camera-Huntsman's Equipment," Marius Maxwell; "Soldier-Pictures That are Different," Beatrice B. Bell. "How to Use the Camera in Camp," E. H. Brown; "Practical Kinematography, Chapter VII continued," Herbert C. McKay; "Photographer, Artist, or What?" Hillary Goodsell Bailey; "In the Cave-Country with a Camera," Russell T. Neville; "Questions and Answers in Darkroom-Procedure," Ed. C. Jerman; "Photographic Chemistry for Beginners," Chas. Francis Hamilton.

Popular Astronomy, Northfield, Minn., for June-July, *$4.00 per year.* "The Swarthmore College Eclipse Expedition to New Haven, January 24, 1925, with Plates XIX-XXI, " John A. Miller; "The Eclipse of January 24, 1925, at the Maria Mitchell Observatory," Margaret Harwood; "The Seagrave Observatory Eclipse Expedition," Lewis J. Boss and Chester A. Mowry; "Meteorological and Other Observations During the Total Solar Eclipse of January 24, 1925," Willis I. Milham and W. W. Stifler; "Climatic Conditions on Mars, Concluded," W. W. Coblentz; "Telegraphic and Published Positions of Comets and Asteroids," L. J. Comrie.

Scientific Monthly, Garrison, N. Y., for August, *$5.00 per year, 50 cents a copy.* "The Coming of Age of the Origin of Species," Thomas H. Huxley; "Life, Heredity and Evolution," William Patten; "Evidence for Evolution," Dr. C. B. Davenport, Dr. Vernon Kellogg, Dr. William E. Ritter, Dr. George G. MacCurdy, Dr. Henry E. Crampton, Dr. Adolph H. Schultz, Dr. William Patten, Dr. Michael F. Guyer, Dr. R. S. Woodworth; "Fundamental Facts in the History of Mathematics," G. A. Miller; "Anthropology and the Endocrine Glands," Dr. Louis Berman; "The Whaler and the Tortoise," Dr. Charles H. Townsend; "The Humanist and I," Dr. Paul R. Heyl; "Radio Talks on Science: Coal," Dr. David White; "Foods Discovered with America," Dr. W. E. Safford; "The Carlsbad Cavern," Dr. Willis T. Lee.

Torreya, Lancaster, Penn., for May-June, *$1.00 per year, 30 cents a copy.* "A Botanically Remarkable Locality in the Tallahassee Red Hills," Roland M. Harper; "Further Notes on Calypso," H. Mousley; "An Additional Anychia from Pennsylvania," John K. Small.

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BOOK REVIEWS.

Laboratory Manual of Experiments and Physics by Leonard R. Ingersoll, University of Wisconsin. Pages ix+220. 14.50x21 cm. Cloth, 1925. $2.00. McGraw Hill Book Company, 370 7th Avenue, New York City.

This manual is one which has been the out-growth of laboratory work for many years in the University of Wisconsin. Although perhaps prepared more particularly for students of this university, it can be just as well used fby any school of the same calibre.

It surely is a splendid book. The directions are clearly written and each student should be able to carry out the experiments without very much assistance from the instructor.

There are 56 well executed drawings made especially for this text. There are 76 experiments which have been well selected. Nearly every experiment closes with questions appertaining to that particular test.

The book is printed in ten-point type, has a table of logarithms, has natural signs and tangents appended. It is well indexed, well made and worthy of being placed in any collegiate physics laboratory in the country.

C. H. S.

Commerce and Industry by J. Russell Smith, Columbia University. Pages x+769. 14x20 cm. Cloth, 1925. Henry Holt & Company, New York City.

A splendid book by a well-known author. A book which shows to us how small the earth really is, due to the fact that we have so many methods of communication and so many ways by means of which commodities are transported from one country to another. Showing to us, also, that the idea of the foreigner is becoming more and more antiquated and telling us that really our home is the earth itself. This is especially true with the civilized nations.

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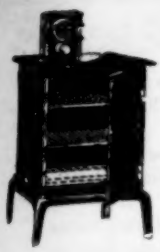
C. H. S.



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Modern School Electricity and Magnetism by R. G. Shackel Coopers' Company's School, London. Pages iv+250. 12.50x19 cm. Cloth, 1925. $1.20. Longmans Green & Company, New York City.

This book is a splendid compilation with the ideas and practises as carried out in England. It is a book which will cause enthusiasm to be created in the minds of any mechanically inclined boy.

A boy who is fond of electricity will have no trouble in understanding the principles and theory laid down in the book. There is some mathematics in the text but it is of an elementary nature and can be easily mastered.

There are one hundred seventy-one finely executed drawings which illustrate clearly the principles which are demonstrated. The major paragraphs begin with bold-faced type which indicates the subject matter to be discussed in that paragraph. Each chapter closes with a list of practical problems, the matter of which is discussed in that chapter. The diction is fine and physics teachers everywhere should become familiar with the book. C. H. S.

Calculus of Variations, by Gilbert Ames Bliss, Professor of Mathematics, The University of Chicago. Pages ix+189. 13.5x19 cm. 1925. Open Court Pub. Co. $2.00.

This is the first monograph published under the auspices of The Mathematical Association of America through funds provided by Mrs. Mary Hegeler Carus. The author of this monograph assumes that the reader has an acquaintance with the elementary principles of the differential and integral calculus. The book is attractively written and will no doubt appeal not only to teachers and students specializing in mathematics, but also to scientific workers in other fields, who wish to get a view of this attractive field of mathematics without having to plod through the mathematical journals and treatises. J. M. K.

Junior Mathematics. Book I, by Ernest R. Breslich, Assistant Professor of Mathematics, The College of Education, and Head of the Department of Mathematics, The University High School, of the University of Chicago. Pages xvi+279. 13½x19 cm. The MacMillan Company, New York, 1925.

One expects a piece of work from Professor Breslich to be done thoroughly. This book appears to be no exception. It is the product of six years of experimentation with seventh year classes in the laboratory school of the University.

The course is organized about the simple geometry of the plane. The geometrical material is studied from the intentional, experimental, and constructional standpoint. The first two chapters are devoted to the study of line segments. These chapters treat such topics as measurement, rules and compass, ratio, squared paper, and graphs. The third chapter is a study of numerical facts by formulas. The fourth chapter is a study of angles. The fifth makes use of the angle and line segment in indirect measurement. The sixth shows the many uses of the circle. The seventh is devoted to geometric constructions and the measurement of the circle. The eighth chapter is a study of formulas and equations met in business transactions. The ninth, and last chapter is made up, chiefly, of practice exercises and tests.

Some of the main features of the text are the following: Algebra is not taught as an organized science, but as a tool in the study of topics. The abundance of work in arithmetic aims to secure proficiency in the manipulation of the fundamental processes that are needed in handling the problems that arise in ordinary life and in the acquisition of further mathematical knowledge. The material is organized in pedagogical units, and the method of approach is inductive. J. M. K.

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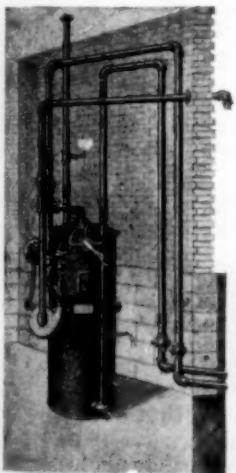

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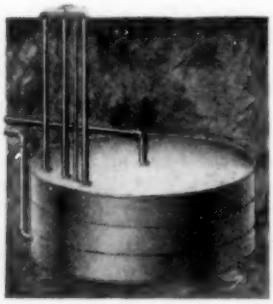

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Objective Studies in Map Location, by Harold Rugg, and John Hockett, Lincoln School. Pages x+132. 13x20 cm. Paper, 1925. Lincoln School of Teachers College.

This is a pamphlet published by the Lincoln School and is thoroughly progressive and says things that are not back numbers, but describes the new things that are being done now.

It is a delight to come in touch with a book like this. It cannot help but make one who has not been careful in his map studies in the last few years, to be of sympathy for himself that he has been so careless as not to keep abreast to the times.

It is hoped that this book will be the means of regenerating many of our Geography teachers and instill into them such new truths that they will communicate it to their students in such a manner as to produce a real up-to-date course of new geography and map teachers.

C. H. S.

Vacation Activities and the School, by the Lincoln School. 64 Pages. 13 x20 cm. Paper, 1925. Lincoln School of Teachers College, New York City.

We are glad that the Lincoln School had the inspiration to publish a little pamphlet like this on vacation activities.

So many people think that a child should be left to himself in the long summer vacation, not doing anything necessarily that will increase his knowledge.

A study of this little book will instill in the minds of parents and teachers the importance of giving the youngster something worth while to do when he has the time to do it, and also he is surrounded by an environment that will be actually beneficial to the child.

Without question, this book will work a revolution in the minds of people who stand for progressive education. C. H. S.

Description of the Science Laboratories of the Lincoln School of Teachers College, by Earl R. Glen, Charles W. Finley, and Otis W. Caldwell, Lincoln School. 39 pages. 13x20 cm. Paper, 1925. Lincoln School of Teachers College, New York City.

One of the most interesting descriptions of a Science Department in any school which has arrived at our desk, is the one described above. Without question, one of the best equipped Science Laboratories in the country, is the one in the Lincoln School, New York City.

The General Science, Chemistry, and Physical Laboratories are described in detail, not only as to the apparatus, but to the general arrangement and equipment of the rooms.

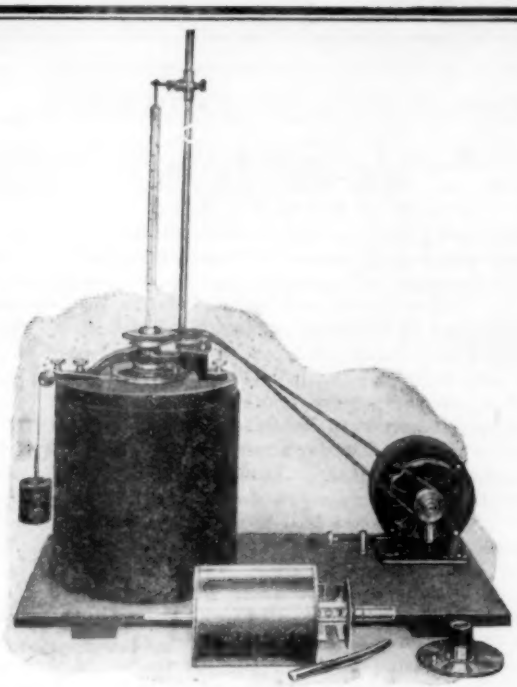
There are drawings of the floor plans as well as several half-tones describing the arrangement of the rooms. Before equipping any new laboratory, the person in charge should secure one of these little pamphlets and, if possible, pay a visit to the school. C. H. S.

Practical Problem Projects by F. W. Rawcliffe, Cicero, Illinois. 112 Pages. 19x25.50 cm. Paper, 1925. F. E. Compton & Co., 58 E. Washington St., Chicago.

This is surely an up-to-date method of presenting the subject of Science to our younger pupils. It is written in an interesting way. It contains over one hundred projects of various forms. It is profusely illustrated which gives the young pupil a clear idea of what the project is about.

It is prepared primarily to make the young pupil think, and not to copy somebody else's idea. As the author says, "the business of the schools today has become a matter of selling an education to a child."

It is a book which any school, which wishes to introduce, more thoroughly, the project method of teaching, should investigate before adopting any other text of a similar character. C. H. S.



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Commerce and Industry by J. Russel Smith, Columbia University. Pages x+769. 14x20 cm. Cloth, 1925. Henry Holt & Company, New York City.

A monumental work, space for this review will not permit an elaboration of the book which it deserves. It has attempted to explain how the earth became the home of civilized men. More than half of the book is devoted to the United States and Latin America receives more than usual attention because of our trade expansion with those countries. The statistics presented have been collected with unusual care and may be relied upon as presenting the truth. The latter part of the book deals with trade routes and the laws of trade.

Major paragraphs begin with bold-faced type and carry the key to the subject matter discussed under those paragraphs. The book is well made and will stand hard usage. Each chapter concludes with a set of questions pertaining to the discussion of that chapter. It is profusely illustrated with 353 well chosen half-tones and drawings. People interested in Commerce and Geography should possess the book and study it carefully. C. H. S.

High Lights of Geography, North America, by David S. Jordan and Katharine D. Cather. Pages xv+358. 14½x21 cm. Cloth, 1925. $1.44. World Book Company, Chicago, Illinois.

A remarkably interesting book for the lay reader as well as for the teacher and pupil of geography. As the name indicates only the more interesting parts of the Geography of North America are discussed. It is a book from which the teacher of Geography will be able to secure much new information.

It is printed in ten-point type on good paper. The diction is splendid. The statements made in it are true and reliable. It is a book which all teachers of Geography should possess. C. H. S.

Essentials of Business Arithmetic, by George W. Miner, Fayette H. Elwell, Professor of Accounting, University of Wisconsin, and Frank C. Touton, Professor of Education, University of Southern California. Pages vi+266. 14½x21 cm. $1.20. Ginn and Co., Boston.

"Essentials of Business Arithmetic," impresses the reader with the significance of the title. The authors have grasped the idea that dominates modern business, namely, essentials. Into the nine short chapters they have concisely arranged and packed about all that modern industry and trading can wish for in order to compute business problems.

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The Graphical Construction of Eclipses and Occultations, by W. F. Rigge, S. J. Crieghton University, Omaha, Nebraska. Pages 157. 17x25 cm. $2.00. Loyola University Press, Chicago, Ill. 1924.

The ability to predict a solar or lunar eclipse, or an occultation, is an accomplishment that may be acquired by anyone who possesses a knowledge of spherical geometry, plane and spherical trigonometry, and access to the American Ephereris of the year, through the reading of this book by Prof. Rigge. He employs the graphical method. After mastering Chapters II and III, the reader may find on a diagram which he has drawn for permanent use, all the elements for a solar eclipse, or an occultation, in five minutes. This book should be of interest to people who study astronomy from the standpoint of the amateur. J. M. K.

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